NEW SCIENTIST

19 July 1962

TELSTAR AND THE FUTURE

JOHN MADDOX

Searching the sea with sound

Professor D. G. TUCKER, *Electrical Engineering Department, University of Birmingham*

Automation in laundries

JACK LEICESTER, *British Launderers' Research Association*

A scientific approach to university teaching

Professor MILES WEATHERALL, *University of London*

The changing map of Jurassic Britain

Dr RAYMOND CASEY, *Geological Survey and Museum*

VOLUME 15 NUMBER 296 ONE SHILLING WEEKLY

NEW SCIENTIST

Cromwell House, Fulwood Place, High Holborn, London, WC1
Telephone: HOLborn 7554. Telegrams: Newscient, London
Volume 15. Number 296

CONTENTS

Notes and Comments 123

Telstar and the future by John Maddox 130

American Newsletter 133

Searching the sea with sound by Professor D. G. Tucker 134

Automation in laundries by Jack Leicester 139

Science in British Industry 142
Protecting jetties with hydraulic fenders: Cleaning beet: Sticky-back ceiling for cars: Containing the sky: Towards the continuous brew: The endless cure: Lamps oust the cathode ray tube.

Science in Overseas Industry 146
"Exploding gas" shapes metal in microseconds: Meter gets scale it deserves: Promising seed dressing: Fluid spring of many parts: Colourless burning: Overcoming water shortage by Dracone: Smooth skinned ingots.

A scientific approach to university teaching by Professor Miles Weatherall 149

The changing map of Jurassic Britain by Dr Raymond Casey 152

It Seems to Me 155

Trends and Discoveries 157
Vacuum adhesion of clean metals: Ants' nests are warmer than surroundings: Is this how abnormal ground water forms?: Bears that bit the dust?: Men spin for two weeks: Chilean forest thrives on fog: The basic structure of a virus coat and some cell membranes: Falling spheres to measure high winds.

Letters 160
Vegans and vegetarians: Freedom from hunger: Aircraft shadow and bright spot: Eye fatigue and fluorescent white paper: Life on other worlds?: The chess playing "robot": Safe use of new drugs: Straightening up in orbit.

Books 162
Reviews by Dr B. P. Levitt, Professor P. T. Matthews, Professor James Brough, C. W. Tonkin, G. Buchdahl, A. J. Watson, John Delin and Dr J. A. H. Waterhouse.

Contributors 165

Classified Advertisements 166

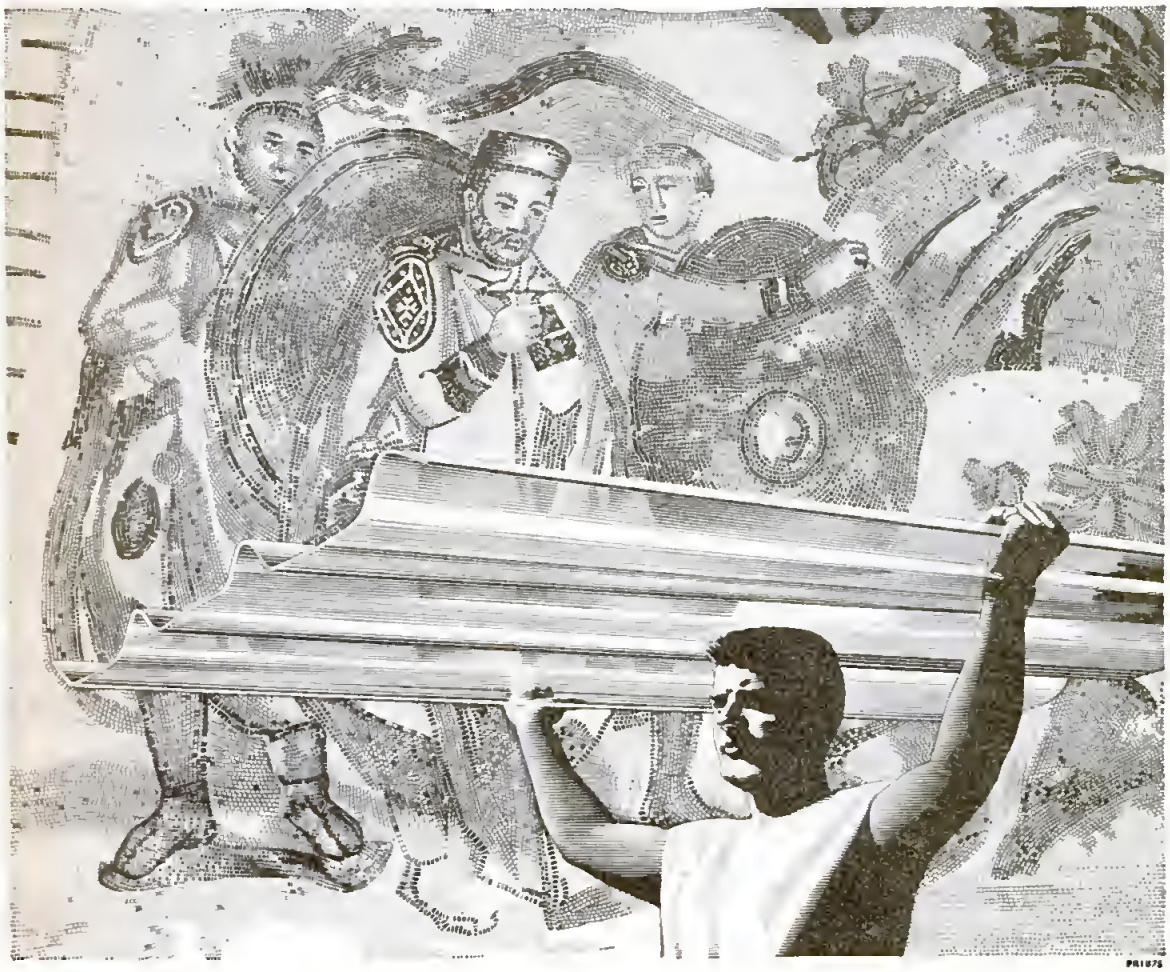
POSTAL SUBSCRIPTION RATES

Inland and Overseas: 60s. a year. 30s. for six months.

Special Rates per year: Canada $10; USA $12; Holland D.Fl 32.

Registered at the G.P.O. as a newspaper. Authorised as Second Class Mail for transmission by Canadian magazine post. Entered as Second Class Material matter at New York Post Office.

Umbrella for an Emperor



Fifteen hundred years ago the Emperor Maximianus Herculius caused a lavish hunting lodge to be built for him in a Sicilian valley. And there he remains to this day, immortalized with gods and goddesses, dancing maidens and all the beasts of the hunt in a spectacular carpet of mosaic. Overhead, to ward off the weather and temper the harsh Sicilian sun, is a 75,000-square-foot translucent canopy of a truly 20th-century material—'Perspex', the acrylic plastic discovered and developed by I.C.I. of England.

Tough, weather-resistant and easily shaped, 'Perspex' appears in one form or another in nearly every country in the world. It provides windshields for Dutch scooter riders and cockpit canopies for French air pilots. It gently diffuses the lighting on German roads, in Swedish petrol stations, Canadian hospitals and Italian trams. Australians mould it into brilliantly coloured lightweight baths and sinks, and it features in many of the world's famous shopping streets in the form of advertising signs. Yet it is only one of a wide range of plastics—the widest in the world—that I.C.I. exports from Britain every year to the value of £18 million.

The influence of I.C.I. research and production is felt today in every corner of the globe

Imperial Chemical Industries Ltd., London, SW.1

in a changing world

An invisible beam, sweeping the sea ahead, gives instantaneous warning of hazards obscured by darkness, storm or fog. This is Radar. A far cry, indeed, from the man in the crow's nest on whose eyes alone the safety of a ship once depended.

Mullard have been privileged to make important contributions to tha progress of marine radar, and thair microwava valvas, cathoda ray display tubes and other spacialized aiactronic davices can be found in the aquipment of leading British radar manufacturers.

As important as the products thamselves, are tha technical and anginaering applications and advisory services which accompany them. These facilities, based on extensive research and development laboratories, are freely available to users of Mullard products.

If you manufacture elactronic equipment – no matter what – and are inferested in such services, please write to us at the address balow.

Mullard products in typical general purpose marine navigation radar sets include :

VALVES CATHODE RAY TUBES
SEMICONDUCTORS
MAGNETIC COMPONENTS

Mullard
ELECTRONICS

. . . . in partnership with progress

ELECTRONIC VALVES AND TUBES
MAGNETIC COMPONENTS · TRANSISTORS
AND OTHER SEMICONDUCTOR DEVICES

Write to the address below, on your company notepaper, for a copy of the illustrated book "Something About Us".
MULLARD LIMITED · MULLARD HOUSE · TORRINGTON PLACE · LONDON · W.C.1

MF 3517

Notes and Comments

A broader task for RRE?

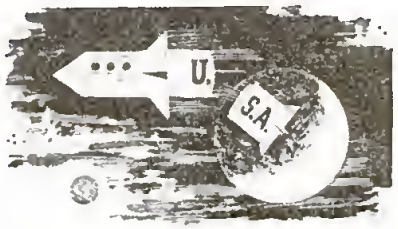
OF the big national laboratories in Britain, the Royal Radar Establishment has perhaps the most romantic history, as the organization which created a decisive weapon in the desperate Hitler era. Today, at its large laboratories at the foot of the Malvern Hills, its primary task is still the development of military radar systems. However, the Establishment possesses expertise and facilities which have direct applicability to civil developments. It is prevented by the terms of its present charter from aiding industry as much as it might. Last week's *New Scientist* urged that the national laboratories should be made more effective as instruments for seizing new opportunities in research which can have widespread benefits to the British economy. RRE is a case in point.

As a natural consequence of its responsibilities in radar the Establishment has to deal with complex automatic control systems and computers, with very low temperature engineering and with advanced electronics generally. It has recently played an important part in the introduction in Britain of techniques such as microwave masers and microminiaturized electronics, and it is at present the main centre for the development of materials for making optical masers. None of these things is of exclusively military interest. In some fields of research, including infra-red detectors and very strong magnets, RRE is in the van of world developments. In the applications of radar itself, RRE has devised an improved system of civilian air traffic control which exploits both the height-finding abilities of the latest military radars and modern data-processing techniques. With Doppler radar methods the Establishment has pioneered radio meteorology for the close investigation of the physics of weather.

While electronics continues in a state of ferment—and there is no sign of the rate of innovation abating—the ability to explore first the physics and then the applications of new phenomena and new ideas is a function which has to be provided by a large experienced laboratory. The industry's own laboratories are very active, but they are not always able to take up research for which the nature and value of the pay-off is uncertain. RRE is able to pass a great many "pre-digested" results and prototype devices out to industry, but the test of military necessity is a continual limitation, however loosely it may be interpreted.

If the Establishment were able to engage more freely in cooperation with industry, in non-military electronics, and to plan its programme accordingly, the benefits would probably be great. The obvious comparison to make is with the Royal Aircraft Establishment at Farnborough which, like RRE, is administered by the Ministry of Aviation and also has a military purpose. It has, however, a much greater opportunity to deal in purely civilian matters. A quite simple administrative change could put RRE in a similar position.

In what kinds of work would enlargement of horizons then be possible? The answer is to be found in looking at some of the major trends in electronics: microwave communications, optical and infra-red electronics, cryogenics, novel physical and logical principles for computers, adaptive control systems for industrial processes, miniaturization carried to the micron scale, and so on. In all these fields existing work at RRE could be conveniently extended, to the greater service of industry.



New plan halves payload for manned Moon landing

THE US National Aeronautics and Space Administration last week announced its strategy for landing the first Americans on the Moon. It has chosen an orbital rendezvous technique which is more economical of rocket power than alternative methods which have been under consideration. The huge Nova booster—which has fallen badly behind schedule—will not be needed for this maiden trip, which it is hoped to accomplish by 1968, perhaps ahead of the Russians. The pioneers will land, not in something the size of a ten-storey building, but in a bathroom-sized capsule which, at a pinch, they could manhandle themselves.

A few days after the NASA announcement, the project was elaborated to a meeting of the British Interplanetary Association by Mr R. O. Piland, deputy manager of Project Apollo. One advanced Saturn rocket booster will suffice for the operation. A three-stage vehicle will send a spacecraft containing three men in a pressurized cabin (the command module) towards the Moon. At a hundred miles or so from the lunar surface retro-rockets will slow the craft into a lunar orbit. It will then be split in two, to form a mother craft and a lunar excursion module. Two of the crew will transfer into the latter, leaving the third man in orbit in the mother craft. The landing party will descend in an elliptical orbit towards a preselected site on the Moon surface. They will be able to control their descent to the extent of hovering above their landing point, or even reversing direction at the last moment to rejoin the mother craft if conditions look unfavourable. Their craft will carry sufficient supplies for 24 hours' exploration in the vicinity of the landing, and 24 hours' additional supplies for emergencies. After their excursion the explorers will re-embark and launch their

Notes and Comments *continued*

vehicle to make rendezvous with the mother craft orbiting above. When the three men are reunited in the main spacecraft, the landing module will be jettisoned and the basic unit, stripped down to the essentials for return and re-entry, will be accelerated out of lunar orbit into a path to return it to Earth. A descent on to land, and some control by the crew of the point of arrival, are envisaged in the re-entry system. The whole mission will last up to a fortnight.

This is the overall plan now adopted by NASA although, as Mr Piland emphasized, many of the details remain to be worked out from experience in the intermediate programmes, Mercury and Gemini. Hazardous though the lunar rendezvous operation may seem, NASA considers it will be easier to achieve with the experience available than either a direct Earth-Moon flight or the method involving rendezvous in an Earth orbit to refuel the lunar rocket before it sets off. Rendezvous in lunar orbit is only one of eight critical in-flight manoeuvres and by no means the most difficult. A much smaller and lighter lunar-landing craft is called for by this plan than in either of the others. The total payload to be accelerated to "escape velocity" will be 80,000 lb, compared with 150,000 lb in a Nova-type method. The possibility of landing supplies on the Moon in advance of the manned landing is to be considered.

Cold appraisal of a wages policy

THE unsuccessful efforts of several post-war European and United States governments to control inflation by indirect deflationary policies have stimulated interest in the possibility of direct control over wages as an alternative remedy. The entire current issue of the *Bulletin* of the Oxford Institute of Statistics is devoted to recent research on wage control and wages policy. Particularly interesting is the report, by M. Cockburn and D. Whitehead (University of Adelaide), of Australian experience.

In Australia, 79 per cent of the employed population have their basic wage in part determined by Federal and State tribunals, established for the purpose of controlling wage increases. As far as the tribunals are concerned, wages are made up of two items, a "basic wage" which is reviewed annually in order to maintain its real value and permit it to increase with economic growth, and a discretionary part to enable differential wages for different skills and in particular for skills that are in demand. This latter part is reviewed infrequently.

There exists therefore a comprehensive system of wage control: what problems have been encountered in administering it? Three problems stand out. The first is whether changes in wages should be related to changes in prices or production. Recent advocates of wages control have emphasized the need for private incomes to grow at the same rate as the output of goods and services. But Australian experience suggests that this is difficult to accomplish because of the pressure from wage earners for their pay to keep pace with prices.

A second problem is that of predicting changes in productivity. One suggestion was that wage increases in any one year should be based in the average economic growth of the previous five years. Unfortunately such an estimate would have underestimated growth in three years and overestimated it in four years between 1954 and 1961. An allied problem is the difficulty of estimating economic growth in sectors of the economy in order to determine sectional increases in pay; this problem is particularly acute in sectors where "productivity" is non-measurable.

But the greatest problem has been what has been called the "earnings drift". Despite control of wage increases, earnings have tended to increase at a faster rate than wage awards. Between 1952-61 the "basic wage" increased by 19.5 per cent: during the same period it has been calculated that earnings of male workers increased by 54 per cent. The authors suggest that this "drift" of earnings ahead of awards is the result of employers paying bonuses and shares of profits in order to attract and retain workers and to induce high output. In turn this practice has produced what the authors call an "earnings scatter": not all groups of workers have benefited equally from the "drift". In some industries earnings increased as much as 40 per cent in the middle 1950s, while in others the increase was as low as 15 per cent. Further, these additional payments were only partly related to increases in productivity; the writers find, for example, that one-third of the industries with the highest rates of increase in earnings were not among the industries with the fastest rates of productivity increase.

New President for Society of Chemical Industry

WHEN the Society of Chemical Industry held its annual meeting at Newcastle upon Tyne last week, the Presidency of the Society was turned over by Lord Fleck to an American scientist and industrial leader, Dr Monroe E. Spaght, President of Shell Oil Company. As a former President of the Shell Development Company, a division of Shell Oil, he had a major part in directing the rapid post-war growth of the petrochemicals industry in the United States—and hence internationally.

It is more the exception than the rule, particularly in America, for a scientist to assume the responsibility for a company whose success depends on coping with the demands of a highly competitive consumer market. But in this new era of science, technology, and industrial management Dr Spaght believes that the scientist, while not having a monopoly of wisdom, has an important role to play in the boardroom.

The scientist, he points out, is at home with many of the characteristics of modern business. He is familiar with its physical processes, but perhaps more important, "he is acquainted with change, and in a time of rapid technological change he is more comfortable".

Dr Spaght's introduction to industry was a happy accident. As a student, he had decided that his satisfaction in life would come from adding to the total sum of human knowledge. He chose to seek this satisfaction in the field of chemical research. At Stanford University and at the University of Leipzig, in the days of Debye and Heisenberg, he grounded himself in the physical sciences, and at Stanford he wrote his doctorate thesis on "Physical Studies of some Simple Gases". But when he was ready to take up an academic career in 1933, America was in the throes of the depression and funds for research were scarce. Taking the advice of his Stanford professors, he sought a job as a technologist in industry—temporarily, for experience.

Looking back now, after almost 30 years with the oil industry, Spaght says: "It was a happy choice. Only those who have been there can understand how useful the technologist can be. New and useful things are brought to life by his labour of applying science to industry. The new, fresh idea is one of Man's finest moments, and the scientist lives in that climate. But the technologist is more than the one who tidies up after the pure scientist. Neither can I be sure that the two are not interchangeable, for the same training makes for both, their paths varying only by practical or unknown impulses."

The new President of the Society is a man of broad interests. With his two sons, he enjoys Arctic exploration on his holidays, and whale-hunts with the Eskimos. Much of his free time is devoted to being a spokesman for the cause of education —before scientific and technical bodies, and to the more general public which can be reached by radio and television.

Example of the hazards of the staphylococcus

ONE of the biggest problems in the modern hospital is wound infection, which still occurs in spite of all the aseptic precautions that are taken. The staphylococcus is usually responsible. Records show that depending on the type of surgery, some 10 per cent of operation wounds subsequently become infected. The possible sources of infection are many: the organism may be airborne, it may be carried by operating theatre workers, it may be on the utensils and dressings, or it may be carried by the patient himself. The most frequent source of infection is the healthy carrier who unwittingly harbours in his nose staphylococci pathogenic to others. With every breath and every word a shower of staphylococci is released into the air from the carrier's nose, where the organisms proliferate undisturbed.

It is not necessary for the carrier to be very near the victim. This was shown during a recent outbreak of staphylococcal wound sepsis at Peter Bent Brigham Hospital, Harvard, which was investigated by Dr Ruth Kundsin, a research associate there. She reports her findings in the *Journal* of the American Medical Association.

Since the bacteria are almost as characteristic of a person as his fingerprints, staphylococci shed by a carrier can be recovered from the air, floor and objects and identified by means of phage typing as originating from that carrier. Dr Kundsin investigated 250 operations bacteriologically. The gauze masks worn by surgeons, nurses and operating theatre assistants were cultured, as well as material from the air, floor and walls of the operating theatre. Patients' skin, clothes and noses were cultured pre- and post-operatively.

But the source of the infection could not be traced. Suspicion ultimately fell on a laboratory technician, who was not previously suspected because he was not a member of the surgical team, and did not come into close contact with any of the patients. Yet his particular strain of staphylococci were recovered from the environment of the operating theatre in 49 per cent of the operations when he was present, although he wore the conventional theatre gown, cap, boots and mask.

Petri dishes exposed on a sterile table were contaminated by the technician's staphylococci, which were the same as those causing the wound sepsis. They were carried in his nose. No patient or any other person in the operating theatre was found to carry the same strain of staphylococcus. Yet the only contact this carrier had with the patients was during the brief time he was in the operating theatre collecting material for pathological examination. The inescapable conclusion is that the mere presence of a staphylococcal carrier for a brief period in an operating theatre can be sufficient to transmit infection to wounds via the air.

Making large crystals of extremely pure metal

IT is no secret that metals are much stronger, more ductile and more resistant to corrosion when obtained in an extremely purified form. Near perfection has been achieved in metal fibres and whiskers, but these do not lend themselves to all forms of metal research. Massive single crystals as pure as 99.9999 per cent are a valuable "half-way house" in which physicists and metallurgists can probe more deeply into the mechanical and electronic structures of metals. Herein lies the clue to why some metals seem to be chronically brittle, or to corrode easily, or to have a shaky fatigue strength. It is, of course, the imperfections that remain in the single-crystal lattice that excite the interest. From these errors in symmetry — the extra, or missing, atom in a row perhaps —derive the electrical properties of a semiconductor or the mechanical attributes of a metal. (That such single crystals are still far from perfect, however, was brought home to a scientist recently when he dropped and shattered a large metal crystal worth several hundred pounds.)

There is a rising demand from researchers throughout the world for single-crystals of metals, alloys and semiconductors. The usual practice has been for the researchers to grow and purify their own material—often an unconscionably costly and time-consuming labour. Methods of growing reasonably large single crystals received little attention before the blossoming of the semiconductor industry—now, of course, the most important commercial outlet for the crystals. One of the most significant techniques associated with semiconductor crystal growing, zone refining, is only a decade old.

This demand was appreciated by a Cambridge research metallurgist, Dr Michael Cole, five years ago, and he conceived the business that now provides metallurgists in over 30 countries with single crystals of metals ranging from low-melting-point tin and lead to the refractories tungsten and molybdenum, embracing rare-earths, precious metals, and a number of binary and ternary alloys. These are supplied to the shape, size and orientation required with a purity of "six nines" or 99.9999 per cent; the best commercial materials (other than semiconductors), such as super-purity aluminium, are 99.99 per cent pure.

The provision of so wide a variety of single crystals, up to 16 in. long and 2½ in. diameter, calls for a number of crystal-growing and purifying techniques. The simplest, used whenever possible by Dr Cole's firm, Metals Research Ltd. of Cambridge, is the Bridgman method of using a crucible with a "tail". A small single crystal is put in the "tail" to act as a nucleus for the slowly-cooling melt. The Czochralski technique of crystal-pulling, in which a small single crystal is dipped into and, while rotating, slowly raised from the melt, is another. This method is well known to transistor makers. Refractory metals with melting points above 1,100°C can be especially troublesome, since often they react with every known crucible material. The floating-zone method of crystallizing and purifying the metal by melting only a narrow band and moving this band along the ingot comes into its own here. Lately, too, the firm has perfected electron-beam melting techniques for zone melting that avoid the problems caused by metal evaporating and spluttering from the molten zone.

Providing a service in single crystals also implies that the crystals be supplied cut to the desired shape and orientation of lattice. Normal methods of cutting metal would induce stresses and recrystallization of a totally unacceptable nature in single crystals. The usual way to cut a crystal is with an "acid saw"—drawing an acid-soaked thread back and forth across the surface—which is painfully slow. Dr Cole's team has developed a spark-cutting technique that gets around the usual strain-inducing propensities of spark-machining. It can be used to produce a 10 micro-in. finish, to plane a surface flat, to trepan out a square hole, to slice a crystal, or to fashion a perfect sphere.

Notes and Comments *continued*

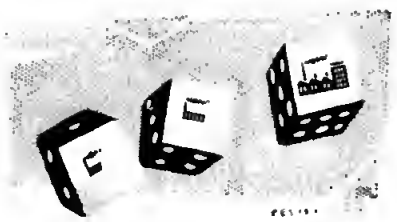
A champion of applied science

PROFESSOR M. W. Thring, Dean of the Faculty of Engineering at Sheffield University, spoke in trenchant terms at a symposium on the principles of applied science leading to industrial development which was held at the University last week. He said Britain was heading for national disaster because of the failure of its industries adequately to develop new products and processes; there were too many cases of British ideas being developed overseas and then reimported under licence. Britain, once likened to a piece of coal surrounded by fish, was now more like a piece of coke inhabited by eggheads—our raw materials were partially exhausted and we must live by our brainpower. But too few of our eggheads were of the right type, too few were being trained in applied science, and too few of our industrial managers understood the principles of applied science.

There is a myth that applied science is for the weaker student and this myth must, in Professor Thring's view, be exploded. The sixth-former must realize that there are two equal opportunities that follow A-level passes in science, and that the choice of entering an applied science faculty involves work of equal fundamentality to that of a pure science faculty, but with the added advantage of more immediate applicability in the nation's industries. There are four stages in the development of a project: the research idea, the small pilot plant, the large pilot plant and full scale production. The best applied scientists are those who can study the problems at each stage from a first principle understanding of the basic science involved.

It is at the third stage of development that Britain is particularly weak—at the large pilot plant stage. This is because large sums of money must be risked where the chance of success is perhaps one in three. Few of our industrialists understand, Professor Thring says, that the man who fails to gamble in the twentieth century inevitably loses in the long run. The future prosperity of Britain depends on our industrialists gambling successfully on the brainchildren of our applied scientists.

Professor Thring proposes, as one method of providing the financial resources for development, the establishment of development consortia to investigate alternative ways of achieving desired objectives and to select the best. Projects such as magnetohydrodynamic electricity generation, continuous steel refining and robot automation could be developed in this way. Each consortium would be financed by a group of companies, encouraged suitably by the Treasury, and would cease to exist after five years—or sooner if a workable solution were found.



Professor Thring summed up the problem raised by the symposium as one of education: our scientists must be educated in applicable science and our government and industrial managers must be educated in the need for successful industrial gambling.

Group behaviour and the origins of war

SOME laws and paradoxes concerning the behaviour of human groups, which might shed light on the causes of conflict, were discussed by Professor L. S. Penrose at a conference on "The Pathogenesis of War" organized in Oxford last week-end by the Medical Association for the Prevention of War. It was a contribution to a wide-ranging meeting that considered animal experiments on conditioning and the behaviour patterns of groups, as well as more overt aspects of national policy and defence, in an attempt to elucidate human aggressiveness and how it might be diverted into other channels than war.

Professor Penrose's suggestion for "Law No. 1" is that an individual joining a group undergoes a normal change of behaviour which involves loss of critical faculty and a reversion to more infantile behaviour. Paradoxically, participation in the group also develops certain virtues in the individual which would otherwise be dormant.

Secondly, groups tend to develop in opposite pairs: one group promotes the formation of an opposing group. Included in this generalization is the fact that a party in office steadily piles up opposition to itself even though its leaders and policies may not change. The third tenative law says that the larger the group the more easily can it be controlled by a small resolute minority (this idea was discussed at length by Professor Penrose in the *New Scientist*, 2 March 1961). The fourth law, or a modification of the third, points to the tendency for sub-groups to form with a group.

Another paradox pointed out by Professor Penrose is that, although war may be regarded as a pathological state of society, there is no corresponding increase in mental disease in individuals in wartime: on the contrary, the State can then more easily absorb borderline psychopaths. He also suggests that the leaders of nations may themselves tend to adopt the altered morality of other individuals in their group, and be more aggressive, capricious and unreasonable than they might otherwise be. Professor Penrose is inclined to regard the events leading to war as a concatenation of normal behaviour—which makes the psychopathology of war difficult. The need he sees is for technical means of avoiding such dangerous concatenation.

Another speaker, Dr F. Kraupl Taylor, discussed group behaviour in the light of an American experiment in which experimenters were able without difficulty to provoke hostility between two groups of 12-year-old boys at a camp—and had to abandon the experiment when fierce fighting broke out.

Dr Anthony Storr, discussing the inevitability of conflict, found it an inescapable part of human nature and suggested that the dream of a perfect world authority was impracticable. Rather than try to rid ourselves of aggression, we had to convert war into debate. Mr Gene Sharp, however, thought that active means of resisting tyranny and aggression would still be required and urged research into "a credible non-military substitute for war" based on non-violent methods.

Teeth as accumulators of strontium-90

THE accumulation in bone of radioactive strontium is one of the main sources of internal body-radiation, and has received much attention in recent years because of fall-out from bomb tests. Concentrations occurring in other calcified tissues have attracted less notice. It was pointed out at the annual conference of the British Dental Association at Nottingham last week that depositions in the developing permanent teeth of young people will be more persistent and at the same time perhaps more predictable than contamination occurring in bone.

This is because bone, particularly during the years of growth, is in an active state of mineral exchange. The bone salts are continuously being returned to the blood-stream either to be excreted or redeposited. But in the teeth the minerals are incorporated by irreversible deposition. They become remote from the bloodstream, and strontium-90 could persist long after it has disappeared from the rest of the skeleton; even after death. It will be permanently embodied as a record of the biological levels of strontium-

90 prevailing during the formation of the teeth, and be available for estimation as long as the teeth remain intact.

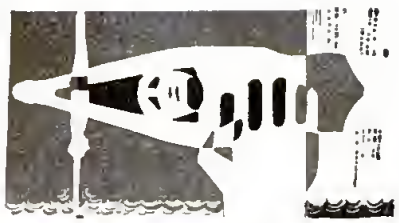
The responsibility for monitoring the teeth of children throughout the United Kingdom has been undertaken by the dental branch of the Royal Navy in conjunction with the Medical Research Council and about 70 associates who send specimens from all parts of the country. This material represents the only calcified tissue available from living human donors; bone estimations are inevitably of post-mortem samples. A vital dental survey can be arranged so as to provide a typical cross-section of the healthy population, or adjusted to examine any particular section of it, whereas post-mortem analyses are adventitious, subject to the possible effects of terminal illness or protracted dietary restrictions. The demonstration at Nottingham dealt with the problems of interpreting results that apply to teeth in different age groups, developing under conditions of varying fall-out concentrations.

Protecting the neck in very high dives

At a cove called La Quebrada, Acapulco, Mexico, exhibition divers earn their living plunging from cliffs 135 feet high into the Pacific. Many have been risking their lives doing this a thousand times a year; veterans have been doing it for 25 years and are still alive. Dr Richard Schneider, a University of Michigan neurosurgeon, who has had considerable experience of treating athletes' neck and brain injuries, has made a special medical study of these divers (reported in *Medical Tribune*).

An untrained swimmer could easily break his neck diving from such a great height. How is it that these Mexicans seldom injure themselves, approaching the water at a speed of 60 miles an hour? In their dive they unknowingly utilize certain mechanical advantages based on sound anatomical principles. The men are very muscular and have exceptionally well developed neck and chest muscles. When they dive the arms are stretched rigidly above the head, and the fingers are locked together, forming a cone-shaped protection for the head. With the legs out straight, and the body as rigid as a rod, this position is maintained during the dive, so that on reaching the water the entire brunt of the impact is taken, not by the head, but by the hands and arms. The force is transmitted to the muscles of the shoulder girdle and dissipated over the body.

The head and neck are protected because they are tucked into a group of powerful muscles formed by the upper



arm and lower neck. In addition the divers hold their necks slightly extended, that is, looking slightly upward, so that the head is not too far back or too far forward. The splinting action of the neck muscles prevents the forward movement of the spine in the region of the neck, which would result in severe flexion of the spine, with fracture dislocation and possibly death from a broken neck. These divers know nothing of anatomy, yet their head and muscles take up the right position for maximum protection. The rigidity of the body, the well-developed neck and shoulder muscles and slight hyperextension of the head keep the spine straight, so that the body enters the water like an arrow.

X-ray examination of the spines of divers who protect their heads in the way described showed no abnormalities. X-ray photographs of less careful divers who allowed the head to take the impact on entering the water showed fusion of some of the vertebrae and old untreated fractures of the neck; when shown the photographs these divers immediately decided to use the locked hands technique. It is not known whether this has any protective action in ordinary platform diving, but its use should certainly be considered in all high diving contests and exhibitions. If it does not save life it will certainly prevent osteo-arthritis of the neck, with its attendant headache, in later life—a price that high divers often have to pay.

A cave study centre is set up in Devon

THE ever-increasing band of serious pot-holers will be much cheered by the news that, for the first time in Britain, a cave research and demonstration centre is to be set up. Named after William Pengelly, the 19th century excavator of Kent's Cavern, the Pengelly Cave Research Centre is to have its headquarters at Higher Kiln Quarry, Buckfastleigh, which overlooks the Dart valley and is some 25 miles from Exeter. The land has been bought by the Society for the Promotion of Nature Reserves and is to be leased for a nominal sum to the Devon Naturalists' Trust, in collaboration with the Devon Speleological Society.

The inauguration of the Pengelly Centre is due to the enthusiasm of Dr A. J. Sutcliffe, a palaeontologist at the British Museum (Natural History), who for some years has been studying the fossil fauna of one of the caves at the site, Joint Mitnor Cave. Discovered only in 1939, Joint Mitnor has proved to contain the most abundant mammal remains dating from the Last Interglacial of any known British cave. The animals evidently fell down a shaft, where their bones were buried. They include hippopotamus, the straight-tusked elephant *Palaeoloxodon antiquus*, the slender-nosed rhinoceros *Dicerorhinus hemitoechus* and many other beasts.

But Higher Kiln Quarry is renowned not only for its palaeontological interest. Reed's Cave is justly famous for its stalactites, and it was here too that John and Winifred Hooper did their classic researches on Greater and Lesser Horseshoe bats, attaching aluminium rings to the wings of several thousands of these creatures. From the geological point of view the caves provide a text-book example of phreatic origin, that is formation at a time when the limestone lay beneath the water-table. The Devonian limestone itself contains masses of haematite and umber, while a lamprophyre dyke is exposed in the quarry.

For the past week, members of the Devon Spelaeological Society and students from London, Exeter and Leicester Universities have been at work on two stone barns at the quarry, which will eventually be converted into a museum, lecture theatre and sleeping quarters. New buildings are to be constructed for research laboratories, kitchen and dining room. The services of an honorary architect have been obtained and a number of surveyors are also giving their time to the project. This is essentially an amateur venture and an appeal for funds and volunteer labour has been launched. In this way the Pengelly Centre differs from cave laboratories on the Continent, such as the one at Moulis in the Pyrenees which is on a national basis under the auspices of the Centre National de la Récherche Scientifique.

Up till now, there have been no facilities in Britain for naturalists who are not also spelaeologists to see cave-living animals such as crustaceans, or the peculiar insects known as springtails; when the Pengelly laboratory is built, they will have every opportunity to do so. Palaeontologists will be able to see a demonstration section showing the stratigraphy of Joint Mitnor cave, as well as bones left *in situ*. Partial exca-

Notes and Comments *continued*

vation of archaeological sites is fortunately becoming fairly common, to afford opportunities for future excavators armed with new techniques; but this is something without precedent in a British bone-cave. The Pengelly Centre will be actively concerned with conservation and education, aiming to check the rate of wanton destruction by thoughtless pot-holers, and the teaching of the principles of good caving to the younger generation is an important part of its programme.

10 years' growth in school science

IT is ironic that Sir David Eccles' resignation as Minister of Education should come at the end of a week in which the Ministry report *Education in 1961* (HMSO, 8s. 6d.) and its associated figures *Statistics in Education 1961 Part Two* (HMSO, 15s.) reveal how much progress has been made. For example, one of the more impressive facts is that the number of students passing Advanced level GCE in mathematics has trebled in the last ten years. Nor are physics and chemistry very far behind.

Indeed, the whole scientific side has moved forward far beyond what might have been expected from the increasing child population of the post-war years. At Ordinary level GCE passes in mathematics increased from 58,420 in 1952 to 121,181 in 1961. For physics the respective figures were 14,435 to 40,518, for chemistry 14,844 to 35,297, and for biology 20,285 to 49,728.

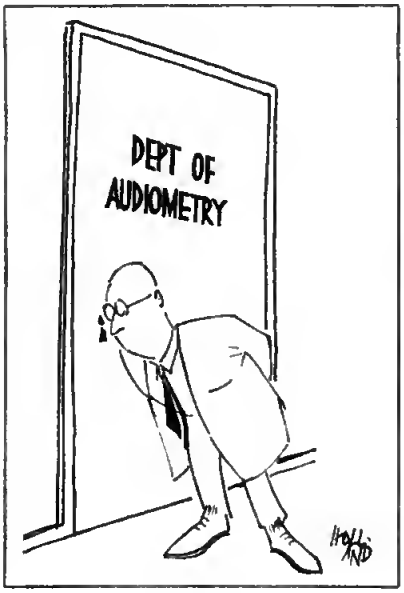
Technical studies also thrived, and the number of students at institutions of further education, not including universities, the vast majority of whom were taking technical subjects, reached the all-time record of nearly 2½ million. Summing it all up, the figures mean that nearly 10 million men, women and children, one in four of the population of England and Wales, were receiving some kind of education in State-helped establishments during 1961.

Looking at the picture as a whole is a favourite standpoint of politicians. The picture is, indeed, encouraging but it does not excuse the black spots. For example, in spite of exhortations from all directions, the proportion of girls successfully attempting science in sixth forms has remained much the same over the last 10 years. In fact, it has very slightly decreased. There still remains one girl for every four boys in our science sixths. Here the figures merely emphasize a report on school laboratories published this month by the Science Masters' Association. This described girls' schools of all kinds as being ill-provided with laboratory facilities and very short of science teachers.

Similarly, in spite of the phenomenal increase of young scientists, the number of trained graduate science teachers has increased by a relatively small amount. In 1959 the total output of university departments of education was 686 science teachers, in 1960 it was 823 and in 1961 it dropped slightly to 821. Not only are these numbers insufficient in themselves; they are grossly inadequate to meet what promises to be a steady increase in the number of pupils as far, at least, as the end of the century. The science teachers, whose report (already quoted in the *New Scientist*) foresees a need for 30,000 additional science teachers in the near future, are hardly likely to be satisfied on this basis. The statistics reveal an expanding educational system enclosing what must become a contracting scientific one.

The hydraulic history of the Wash

AS usual, the latest annual report of the Hydraulics Research Station at Wallingford is full of interesting detail on the work the station carries out on such things as dams, flood improvement schemes, harbours and sea defences. One section is concerned with an investigation of the old coastline of the Wash, which itself is part of a study of the maintenance of a natural regime in estuaries and of how mud flats and saltings are built up.



It had been suggested that progressive siltation and the advance of mud flats and saltings might happen only when the process of deposition and erosion was upset, either by a large-scale natural disturbance or by the works of Man, and that when the balance was disturbed there would be a fast forward growth until a new equilibrium was established. If this were true, it might be possible to trace the edges of old salt marshes and by excavating there, find a sudden change of strata where the change in conditions had occurred.

Recent records of salt marsh movements around the Wash showed no periods of stability, because in the last 300 years and especially in the 19th century there has been so much engineering work done that the effect has still not fully worked itself out. Before 1650, however, there was a long period when the Fenland was protected from the sea by a bank, called the Roman Bank, and by high ground; and in front of the bank there should, according to the theory, have been a narrow strip of permanent saltings and a wider stretch of mud flats. There should also have been a well-defined line between the two, and if the saltings had advanced later on, the line should still be distinguishable. If, on the other hand, the growth of salt marshes was a continuous process when there was no human interference, there would be no such line.

Aerial photographs were searched for an old salt marsh edge, and one was found on Holbeach flats. When it was inspected on the surface a distinct difference could be seen between saltings, the older ones being lighter in colour. A trench was dug across the line. The strata showed that there was a discontinuity, and others were found at various places round the Wash, marking the limits of salt marsh advance and representing a break of probably centuries.

Up to now it has been held that, in the 13th century, the advance of saltings in the South Holland area blocked the outfall of the Great Ouse at Wisbech, caused a disastrous flood and changed the course of the river which now discharges at Kings Lynn. The Station's findings, based on the digging of another trench, suggest that in fact the events must have happened the other way round, so that the large advance in the permanent saltings was the effect of the river's changing its course and not its cause. The study also suggests that, although the engineering works built in the Wash in the last 300 years have been followed by almost continuous advance in the saltings, the pattern of accretion and erosion, and the tendency to equilibrium, are still the same in the Wash as it is elsewhere.

DO NOT ADJUST YOUR SET

THIS IS ONE OF THE GREATEST TV PICTURES EVER!

Not since Marconi end Beird first pioneered redio and television broedcesting hes there been such e historic transmiesion es occurred eerly on the morning of Wednesdey, July 11th. Then, for the first time, Britsin received the picture of e men's face trensmitted from Americe vie 'Telster', the communicetions setellite. The picture wes picked up et the G.P.O's Goonhilly Downs trecking station, on the southern tip of Cornwail, and then fed into our own TV network. For such en operetion, precise trecking is essentiel, and the Hewker Siddeley Group is proud to hsve supplied much of the trecking equipment. Under the supervision of the Goonhilly Downs Stetion consultents, Husbend and Co. of Sheffield, driving motors, control end servo equipment wers mede by the Brush Electricel Engineering Co.; position meesuring encoders were designed and menufectured by A. V. Roe end Co.; end the digitel equipment supplied by Whitworth Gloster Aircreft. The Hewker Siddeley Group congratulate everyone, on both sides of the Atlentic, who mede thie venture possible.

Goonhilly Downs Space Communications Station ▶

HAWKER SIDDELEY GROUP

18 St. James's Squere, London, S.W.1.

Telstar and the future

After Telstar's initial triumph, fingers will remain crossed until it has been established that the vital parts of the satellite have a long life in the exacting space environment.
A practical system of satellite communications will probably use vehicles significantly different from Telstar and in much higher orbit

by John Maddox

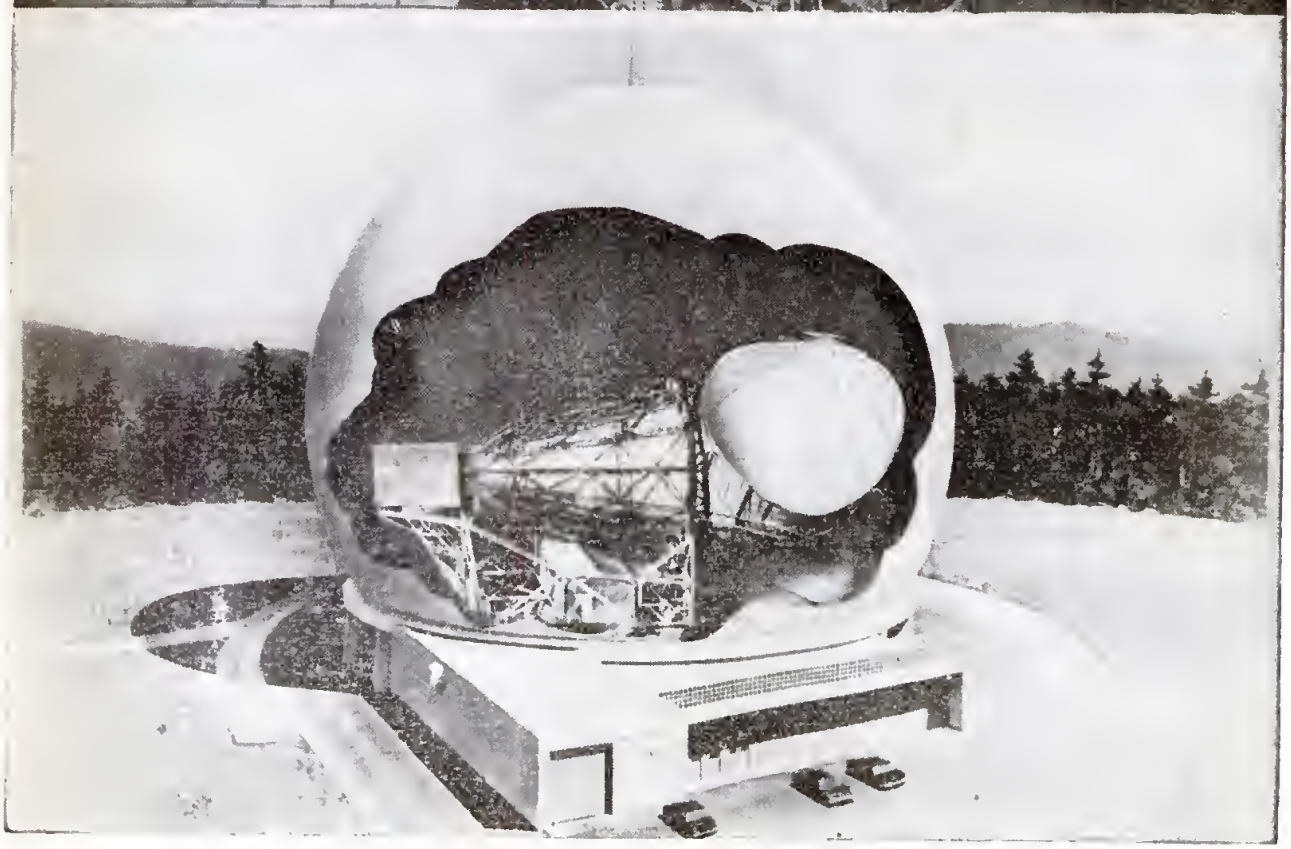
The marked difference in the British and American approach to the design of ground stations for the Telstar experiment are apparent in these pictures. The British station (above) has a simple dish reflector, while the United States' station (opposite) at Andover, Maine (like its counterpart at Lannion in France) uses a large horn aerial.

TELSTAR may have pointed the way to a new era in international communications, but from many points of view the most striking aspect of the first week's work with the satettite was the accuracy with which its behaviour was predicted in advance. It has brought few surprises to the communications engineers who have danced attendance at its home ground base at Andover, in Maine, on the north-eastern seaboard of the United States; at Lannion, in Brittany, where the French Post Office and broadcasting network are installed; and at the two grouod stations in the United States which have worked closely in conjunction with Andover. In Tokyo the authorities were enthusiastic at the first television pictures, and are making plans for televising the Olympic Games, due to be held in 1964. In Britain the difficulties at first experienced with the reception of signals from Telstar have now been forgiven if not forgotten, and everybody at Goonhilly is delighted with what Telstar can accomplish.

The predictability of Telstar extends also to the rocket which launched it at 9.35 a.m. (BST) on the morning of 10 July. The Thor-Delta which did this job left the ground within minutes of the time set several days in advance, and the orbit of the satellite appears to have been almost identical with that aimed at—ooe ranging from 500 nautical miles at perigee to 3,000 nautical miles at apogee. The time taken to complete one orbit differed only by one minute (in 150) from that calculated. To those who waited for the apogee to be suitably placed above the Atlantic for the first time, the near perfection of this launching was at once an augury of good things to come and yet another proof of how the Thor-Delta rocket has become the workhorse of the American space programme.

The first television pictures to be sent across the Atlantic were received in France and in a garbled condition—at Goonhilly on the fifth orbit, soon after 10.30 p.m. (BST). On the following orbit, when the satellite was simultaneously visible from Europe and Andover, Maine for nearly half an hour, still more striking results were obtained in France, but the television signals at Goonhilly were still a largely unintelligible mess, hardly comparable in quality with those sent across the Atlantic by the then misguided visionary Baird in 1928. On the same orbit television pictures were sent the width of the American continent, and still later, across the Pacific.

The public impact of these events has served to obscure some of the hard work which goes with the proving, for the first time, of a new technique in radio communications. From now on it is likely that the ground stations like that at Goonhilly will be fully occupied on a programme of testing, not merely with television but with telephone communications, Telex, and facsimile transmission. Soon there will be other satellites than Telstar to keep track of. The very similar Relay satellite will be launched by the National Aeronautics and Space Administration later this year. Next year will come the first in a more advanced dynasty of communications satellites—the Syncom prototype which has been developed by the Hughes Aircraft Company for NASA, and which will be able to relay one telephone conversation from a synchronous orbit 22,300 statute miles above the surface



Telstar and the future *continued*

of the Earth. In all this testing programme the communications engineers insist that day-in and day-out reliability is all that matters.

From this point of view the accident which marred the first results at Goonhilly is merely a failure of public relations, though a conspicuous one. It arose because of the way in which radio transmissions from the Telstar satellite are intended to be broadcast in a circularly polarized form. To eliminate the interference that might be caused by radio waves of any other but the intended kind of polarization, the receiving aerial on the ground at Goonhilly is provided with a kind of polarization filter. But in the event there was a mistake in deciding whether left-handed or right-handed polarization would be sent out from Telstar. Though it may be true, as the Post Office claims, that this was an understandable ambiguity, the result was as frustrating as an attempt to thread a left-handed bolt through a right-handed nut. But at Goonhilly the essential correctness of the design of the aerial and its associated equipment was confirmed the following night, when the polarization filter had been correctly mounted.

Since the night of 11 July a great many experiments have been carried out. Spurred on by what seemed to be a breach of the agreement within the European Broadcasting Union, when the Lannion transmitter broadcast via Telstar recorded pictures of a torch-singer and a guitarist, television pictures were sent from Goonhilly across the Atlantic. On following nights use was made of the two orbits when the satellite was mutually visible from both sides of the Atlantic for more than a few fleeting minutes, to send telephone signals, facsimile pictures and torrents of Telex information. Everybody concerned with the experiments has been anxious to point out that performance is every bit as good as the designers of Telstar promised.

In this sense performance is judged by the technical criterion of how little unwanted "noise" or atmospheric accompanies the meaningful signal received from the satellite. The standards set for the first Telstar experiments are comparable with those laid down for the conduct of international telephone traffic by landline and submarine cable, so that the satellite (and others like it) should be able to support a broadcasting system of the highest quality. But communications engineers are cautious people, so that it is hoped, in the weeks ahead, to seize every opportunity to test the quality of these transmissions at times when the ionosphere is seriously disturbed, or when aircraft happen to fly within the aerial beams. Already one of the hopeful lessons at Goonhilly has been the discovery that the aerial can still pick up meaningful signals from the satellite when it is pointed only three degrees above the horizon. Until 11 July it had been feared that communication with a satellite like Telstar would be too encumbered by noise at an angle of five degrees.

To accumulate experience of operating aerials like this is obviously an important part of any programme intended to turn communications satellites into everyday means of international broadcasting. More critical, however, is the satellite and its equipment. In this sense there is no doubt that the questions at the back of everybody's mind concern the workings of the 170 lb of equipment which has been fashioned at the Bell Telephone Laboratories in the last two years. Two parts of the satellite are of particular interest These are the solar cells intended to turn the Sun's energy into electrical power which can be used for running the electrical equipment, and the single electronic tube, known as a "travelling wave tube," which is used for amplifying the signals received by the satellite no fewer than ten thousand million times.

By now there is plenty of evidence of how the thin and delicate pieces of semiconductor used for turning sunlight into electricity can be damaged by the streams of atomic particles encountered beyond the atmosphere. Since for a good part of the time the Telstar orbit lies close to the more intense parts of the Van Allen radiation belt, it has long been apparent that the silicon solar cells would be especially vulnerable. This is why each of them has been protected with a thin wafer of artificial sapphire, but even so it is expected that the device will cease to function properly three years or so from now.

The travelling wave tube is a more critical unit, principally because there is only one of it. Its function is to allow the signals on an incoming microwave to modulate the motion of a narrow pencil of electrons moving along a vacuum tube, and then to use this beam to generate a second microwave, with the same modulation but a different frequency and greatly enhanced power. Not merely must this component continue to function over the years, but it must do so with undiminished efficiency, and at the prescribed frequencies. At the Bell Telephone Laboratories such a travelling wave tube has been kept continuously in operation for three years, so that there is some tangible cause to expect success. But all who load so many eggs into one basket must needs keep their fingers crossed.

By now there is, after all, ample evidence that the longevity of individual satellites may be as important to the commercial success of this new route for communications as the longevity of atomic power stations promises to be for the commercial profitability of the atomic power programme. This point has been most clearly emphasized by Dr William Meckling, of the RAND Corporation. Calculations of his show that the annual cost of a single telephone channel via a satellite which can be expected to last five years should be roughly one-half of the cost of the same communications capacity provided by satellites lasting only a year. Fifteen-year satellites should give service at a third of the cost of one-year satellites. Obviously factors like these will in the long run determine the point in time at which communications satellites will be put into routine service. Though there is no doubt that sooner or later it will be practicable to design them to last reliably for years on end, this may not be possible tomorrow or even the day after.

If Telstar will help to resolve the crucial question of reliability, it will unfortunately do very little to clear up some of the other uncertainties which beset the future of satellite communications. Chief among these is the present ignorance of the kind of satellite system which should in future be adopted. For practical purposes the choice seems to lie between a system of a dozen or so satellites circulating at 6,000 or 8,000 miles above the equator, as the GPO (among others) has suggested, or a system of satellites placed at the synchronous height of 22,300 miles in such a way that they would seem to hover above the same spots on the equator. By comparison the scheme in which upwards of 50 satellites would thread random orbits over the poles, quickly attainable though it might be, has few attractions.

In practice, however, all the more advanced systems of satellite communications require the development of techniques far ahead of those incorporated in Telstar. They call for devices for controlling the orientation of satellites, for example, and for keeping them accurately on predetermined stations. The years ahead will demand the development of techniques such as that proposed at Farnborough for using gravitational forces to keep a satellite's aerial pointing towards the Earth. It would seem that sooner or later nuclear power (on a small scale) may offer advantages as a means of keeping equipment running.

From this point of view, of course, the significance of all that has happened in the last few days, at Goonhilly and elsewhere, lies in the way tangible expression has been given to what until recently was only a dream—even a hallucination—among devotees. But as in other fields of technical endeavour, it is one thing to turn dreams into reality, and quite another to make money-spinners of them. Enough has been done to justify optimistic expectations concerning communications satellites, but it would seem rash to predict when they will finally be realized.

American Newsletter

★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★

from JOHN LEAR

Telstar sets some diplomatic problems

NEW YORK

TELSTAR, the first privately-owned moon ever to be hung in the heavens, is only a week old. But it is already one of the most popular diversions in American history. Millions of people scattered throughout the country take pride in exclaiming some variant of the excited cry of a lady who works in my office here: "Just imagine! I was so thrilled! Yves Montand! Live! Straight from Paris!"

The front page of the normally reserved *New York Times* read like a space fever chart during most of the week. On Sunday, a two-column headline at the bottom of the page; on Tuesday a momentary quiet there but a two-column lead editorial inside; on Wednesday a three-column head on the right-hand side of the top of the page; on Thursday photographs three columns wide flanked by a fourth column of head and type on the left-hand side of the top of the page; and on Friday an inside page news announcement of President Kennedy's personal involvement in a Telstar performance fixed for 23 July. Lesser newspapers in lesser cities were less restrained. Rarely has the American Telephone and Telegraph Company cornered so much of the available free advertising space for so long a period.

"Masterful public relations," everyone in the profession is saying now of the first communications firm to have the wit to hire the United States Government to fire a rocket. I wonder, though, whether AT&T will be so happy about all this attention six months or a year from now. The emphasis on global TV is out of proportion to any picture of future prospects that I have been able to put together.

Eight o'clock at night is still the favoured hour for stretching out in a living room chair and looking at the TV screen in a New York apartment. The habits of the people of this metropolis are too deeply set to allow that hour to be moved very far in either direction. And when it is 8 p.m. in New York it is—

3 p.m. in Fairhanks, Alaska, and in Honolulu;
4 p.m. in Juneau, Alaska;
5 p.m. in San Francisco;
7 p.m. in Mexico City;
10 p.m. in Rio de Janeiro;
1 a.m. in London;
2 a.m. in Bremen, Brussels, Budpest, Danzig, Oslo, and Paris.
3 a.m. in Capetown and Johannesburg;
4 a.m. in Moscow;
6.30 a.m. in Calcutta;
8 a.m. in Bangkok;
10 a.m. in Tokyo; and
11 a.m. in Melbourne.

Events that occur in these distant places are obviously not going to group themselves around that point on the clock which corresponds to 8 p.m. in New York. Happenings of great human interest will continue to happen everywhere in relation to local living patterns. What, then, is likely to be the real advantage of global TV? Will the Telstar or other Earth satellites be any more effective as communications devices—will they be even as effective as films or tapes made when and where the news occurs and flown by jet plane to TV distribution points down here on the Earth's surface?

The time question is not the only question that must be asked about Telstar as a TV medium. There will be questions of censorship to avoid inadvertent insults and otherwise objectionable matter. It is commonly recognized that effective translation of the spoken word requires thorough knowledge of folk lore, the vernacular, proverbs, and colloquial jokes. Unfortunately, many who plainly see these obstacles think of pictures as an international language. Only the anthropologists, it seems, are able to keep in mind for very long the fact that people from different cultures see different things in identical pictures. Anglo-Saxon, Latin, Scandinavian and Germanic races each make their own interpretations of a given set of lines or alternating notes of light and shade.

President Kennedy's press secretary, Pierre Salinger, has announced that a study of such problems has been started with a working paper in the Federal Communications Commission. This comes a little late. On 30 November, 1960, a two-volume report covering this area was turned over to the National Aeronautics and Space Administration by the Brookings Institution. It would seem time to credit NASA with foresight, as well as with most of the work of launching Telstar.

It would also seem appropriate to let the people know that Telstar isn't up there to broadcast TV but to test the sending of telephone and telegraph messages at commercial rates. As long as the taxpayers are footing the bill, they ought to be given the particulars straightforwardly instead of being diverted by a heavenly peep-show.

Picture transmitted from Andover, Maine, via Telstar, and picked up in France. Left, Frederick Kappel, chairman of the board of American Telephone and Telegraph Company.

Searching the sea with sound

At an international symposium on sonar systems held in Birmingham last week the future of non-military sonar (asdic) was discussed. Improvements in technique should make possible the observation of individual small fish, while the study of the sea-bed will be assisted by better directional devices

by Professor D. G. Tucker
Electrical Engineering Department, University of Birmingham

SONAR (Sound Navigation and Ranging) has been coming into the open recently after many decades of hiding behind the screen of security restrictions. Last year an important Nato "advanced study institute" on underwater acoustics was held in London, and although only a few selected experts were invited to take part, the institute's work will shortly become generally available through the publication of its Proceedings (Plenum Press, New York). This year another important step has been taken: the holding of a fully-open Symposium on Sonar Systems—thought to be the first ever of this scale and scope—last week at the University of Birmingham under the joint sponsorship of the British Institution of Radio Engineers (Electroacoustics and Radar Groups), the Institute of Physics and Physical Society (Acoustics Group), and the Electrical Engineering Department of the University of Birmingham, which has a large sonar research programme. Most of the papers were concerned with fundamental problems of sonar, which apply equally to its use in military operations (such as the detection of submarines) and in non-military ones; but seven dealt specifically with important non-military uses, such as in fisheries research and operations, hydrographic surveying, and geophysical and oceanographic research. It has, indeed, become quite clear in recent years that non-military applications of sonar, which also include navigation, are growing rapidly in importance, and it is largely their needs which call for the open exchange and publication of scientific and technical information.

Sonar—or "asdic" as it has traditionally been called in Britain—is concerned with gathering information about the presence, position and nature of objects by means of sound waves. It most frequently takes the form of an echo-location system used in water. The typical simple sonar system, like a radar system, uses the transmission and reflection of a pulse of energy as its basis: it comprises the main components shown in Figure 1. Individual systems show many variations on this theme.

The transducers for converting the electrical signal into an acoustic one, and vice versa, may be regarded as a sort of loudspeaker and microphone respectively, although they generally rely on either the magnetostrictive or piezo-electric effects for their operation.

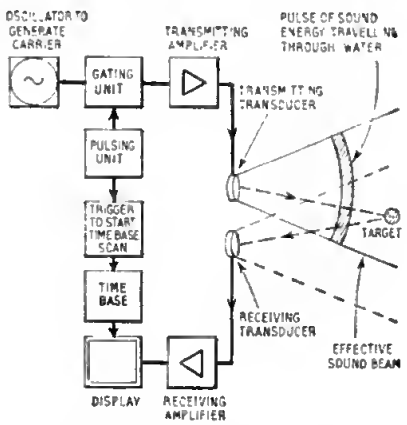


FIGURE 1. *Schematic arrangement of a typical pulsed sonar system.*

Although cathode-ray displays are being increasingly used, the commonest type of display in simple systems is still the chemical recorder, in which a moving roll of impregnated paper is scanned by an electric stylus. Typical recorder traces are shown in Figure 2. If there is a definite reflecting object—or "target"—in the sound beam, then the echo-pulses it produces give consistent marks on the trace at each traverse and form a line down the paper. If the range of the target from the transducers does not vary, then this line is parallel to the direction of motion of the paper. If the range changes because of the motion of the target or of the ship on which the equipment is fitted, then the line is sloped relative to the paper motion.

General problems.—The papers at the symposium were of two main types: one concerned primarily with the equipment and the other with the medium (the sea) and the target. Among matters concerning equipment were the general problems of how arrays of transducers could be used to produce more narrowly directional sonar beams, how beams could be made narrower without increasing the size of the array, the properties of three-dimensional arrays, the general problems of signal processing and of display (that is to say, the "information theory" of sonar), and practical arrangements to meet specific needs.

Concerning the medium, propagation is the most perplexing subject; for however good the equipment may be, its performance as a sonar will always be limited by the perversities of acoustic propagation in the sea. Refraction due to thermal gradients, varying salinity, etc., absorption of energy by conversion into heat, scattering due to inhomogeneities and to rough boundaries (sea-surface and sea-bottom—and one paper dealt with the effects of rough ice), all make sonar performance hard to predict and unreliable. Other topics concerning the medium included the difficulties of obtaining constant echoes from complex targets when the transducers are on a moving ship, and the directional properties of the ambient noise background in the sea.

Non-military applications.—The most interesting part of the symposium for the non-specialist was probably the final informal discussion on the future of non-military sonar. An account of the main points which emerged is given below. This necessarily to a large extent corresponds with the research programme in sonar of the Electrical Engineering Department at the University of Birmingham, since this group is concerned entirely with non-military applications, and is probably the largest such group in Europe. But other British groups, such as those at the

National Institute of Oceanography and at the Fisheries Laboratories at Lowestoft and Aberdeen, contribute to the programme and help in its formulation. In the discussion many other interesting and valuable proposals were made, which, however, are still very speculative. One of these related to the use of air-sonar for the control of hovercraft. There was also some interest in medical applications of the principles of sonar.

Fisheries research and fishing operations.—In fisheries work it is necessary (among other things) to know the whereabouts and movements of fish, and their numbers, size, species, etc., and in these respects sonar offers a prospect of being able to provide the information. Hitherto single-beam sonar has been used, and when used vertically as an "echo-sounder" gives valuable information about the fish beneath the ship. Unfortunately the ship usually has an up-and-down motion, which causes the echo-trace from the sea-bottom to form a wavy line as the ship progresses along its track (as can be seen in Figure 2), and this makes it difficult to detect fish which are very near the bottom. Means have been developed, however, for referring the chart zero to the sea-bottom, so that fish echoes appear at their proper height above an approximately flat bottom trace. Cathode-ray displays of such bottom-locked echoes are very valuable, too, and it is also possible to count the fish passing through the beam within a given height above the bottom when the beam is fairly narrow.

When the beam is used nearly horizontally, so that a large volume of sea can be searched, the single-beam sonar falls very far short of ideal performance. As it is necessary to wait in every position of the beam for one or two transmitted pulses to return from any fish at maximum range before moving the beam to a new position, it is clear that with a velocity of sound in water of only about 1 mile/sec it takes a long time to search a large area with a reasonably narrow beam. Thus much information is lost. A promising development in this field is the "within-pulse electronic sector-scanning" sonar, which enables a narrow receiving beam to be swung over a wide sector ("insonified" or illuminated by the transmitted pulse) so fast that the receiver virtually looks in all directions in the sector at once. A suitable cathode-ray display enables information from the whole sector to be presented on a single pulse transmission (see Figure 3, which shows a shoal of fish in the North Sea as seen by an experimental sonar using relatively coarse resolution. Such equipment has already been used in fish research, and has great potentialities.

A high-resolution version of this system, giving 0.5° angular resolution over a 30° sector of a few hundred feet radius, with

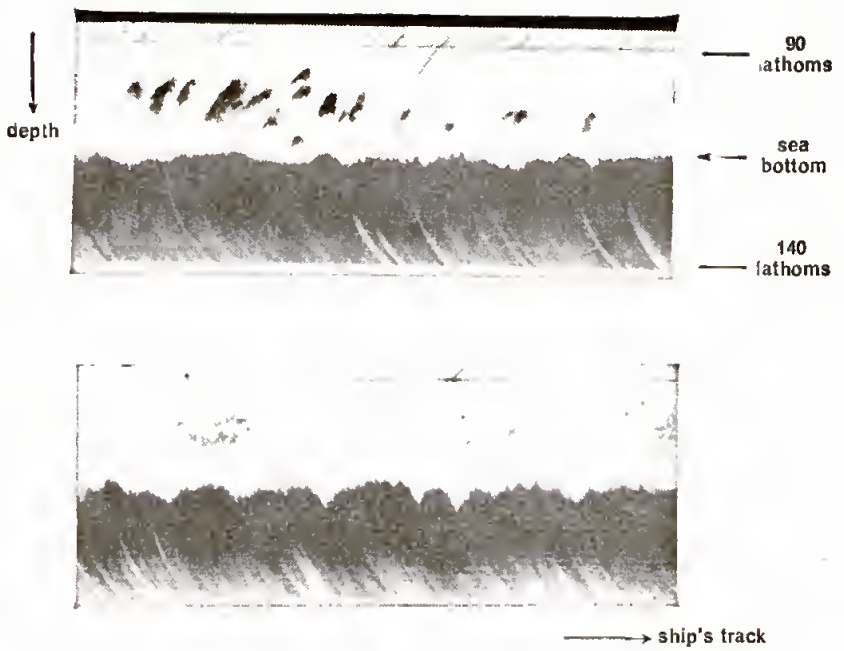


FIGURE 2. *Typical echo-sounder traces on chemical recorder paper, showing sea-bottom profiles, with small shoals of cod in mid-water. In the upper picture these are agglomerated; in the lower they have become diffused.* (*Courtesy*, Journal of British Institution of Radio Engineers.)

6-inch resolution in range, was demonstrated at the symposium. It is hoped that such an equipment will enable the movements of *individual small fish* to be studied. The maximum range at present is limited by the use of a relatively high frequency (500 kc/s) which enables the transducers to be of manageably small size, but suffers a high absorption loss in the water. It seems desirable that the principle be

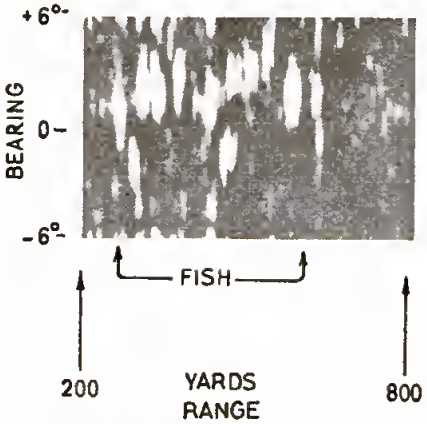


FIGURE 3. *Typical display of fish shoals obtained with an electronic sector-scanning sonar with 1.5° resolution.* (*Courtesy*, Journal of British Institution of Radio Engineers.)

extended to lower frequency systems with ranges of the order of a mile or so and with higher angular resolution; but whether such high resolution can be obtained at such ranges in shallow, inhomogeneous and turbulent water has yet to be investigated.

Present electronic scanning systems use a fan beam which has a relatively large vertical angle (say 12°) and scans only horizontally. But clearly fisheries research calls for the scanning of pencil beams in two planes. Suitable and economical array arrangements were discussed in a symposium paper, but whether it is possible to scan fast enough to cover a large solid sector without loss of information has yet to be determined.

Another matter in which sonar may be able to help is the identification of fish. Hitherto fisheries experts have had to make some sort of identification from the nature of echoes from shoals. Apart from the possibilities which may be developed of actual delineation of the larger fish, there are possibilities also in the use of a very wide frequency band for the sonar signal so that the frequency-response of the fish as a sonar target could be displayed. Directional sonar systems with constant directivity over a 10-to-1 frequency range are under development for this purpose. It has not yet been determined whether this would identify the larger fish, but it cer-

Searching the sea with sound *continued*

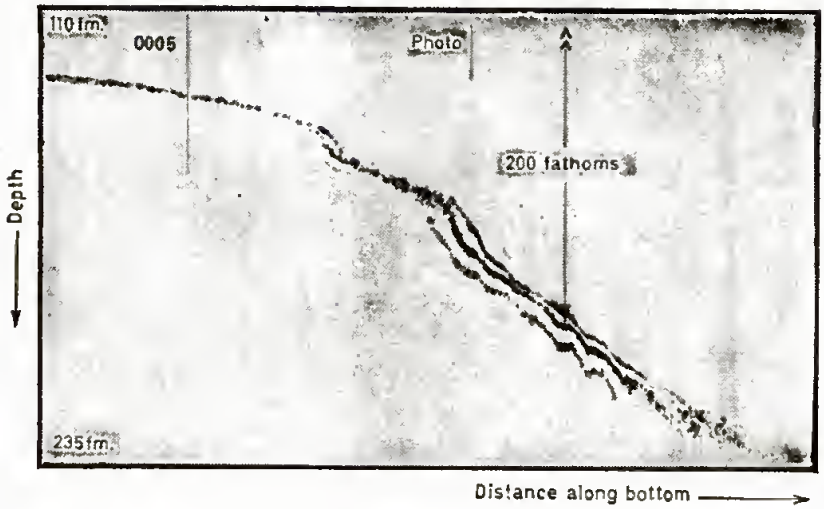


FIGURE 4. *Sector-scanned record of 45° slope on sea bottom. (Courtesy, Institute of Navigation.)*

tainly does seem promising for small fish, such as those comprising the deep scattering layer. This is a relatively dense mass of small organisms, occurring widely in the oceans, of great potential importance as foodstuff, whose existence has long been known from echo-sounding records, but whose constitution and distribution is only slowly being discovered. These small fish appear to have resonant frequencies (due mainly to the swim-bladder) in the usual sonar frequency range. In addition to the development of equipment, much more theoretical and experimental research is needed on the echo response of various kinds and shape of fish (as well as other targets).

The point was repeatedly made in several discussions during the symposium that any sonar which was intended for use by fishermen in commercial operations (as distinct from research) must be cheap. This requirement emphasized a proposal that simple frequency-modulation sonar with aural—not visual—presentation of information might be successful.

Hydrographic and oceanographic surveying.—Sonars, in the form of echo-sounders, have been used for a long time in obtaining depth soundings for navigational charts, and much work has been done in making the equipment basically accurate and in determining the velocity structure of the sea so that time of travel may be accurately converted to depth. Thus under reasonably good conditions and with a flat sea-bottom, soundings accurate to a few fathoms are now possible at depths of several thousands of fathoms.

The big limitation of existing systems is the wide beamwidth used—commonly over 30°. On a sloping or irregular bottom there is thus always an uncertainty as to the point from which the first echo returns are received, and thus accurate surveying is impossible. Very narrow single beams have disadvantages, too, and it seems that a great advance may be possible by using electronic sector-scanning sonar in this depth-sounding role. A profile of the bottom can be obtained in this way not only with many fewer traverses by the ship, and with much greater accuracy, but also in worse weather conditions. Figure 4 shows a steep slope on the edges of the continental shelf recorded with a single pulse by a very crude experimental system.

Even simpler devices than a scanning sonar can be used to improve surveying. Figure 5 shows a record obtained using a multi-beam non-scanning system. In this case three narrow beams of about 1.7° width (at the half-power points), with 6° spacing, were formed by a two-transducer system. On a slope, different ranges are measured by the three beams, so that three separated traces are obtained; the spacing measures the slope. In the case illustrated, the beams were arranged in the fore-and-aft plane, so that the slope indicated agrees with that determined from the profile of the trace as the ship moves along.

It has already been shown that sonar can be used to give valuable information on the geological nature of the sea-bottom due to the different scattering properties of different kinds of rock and sediment (see A. H. Stride's article in the *New Scientist* of 11 May, 1961). It is probable this kind of use can be refined; possibly wide signal-frequency bands will improve the quality of the information obtained. The use of high-power sound sources (such as explosions, sparks, mechanical impact) is already permitting penetration of the upper layers of the sea-bottom as in geophysical (seismic) methods. Evidently coosiderable development in this direction may be expected.

It is possible that methods will be found of using sonar systems to measure ocean currents at various depths by exploiting the Doppler shift of frequency in the sound back-scattered by the inhomogeneities in the water.

Special problems arise in the surveying of inland waters and particularly waterways, where wide but shallow channels are concerned. Attempts to solve these problems (as represented in a symposium paper, for example) have so far relied on a multiple assembly of individual sonar systems; but new and more economical methods are perhaps possible.

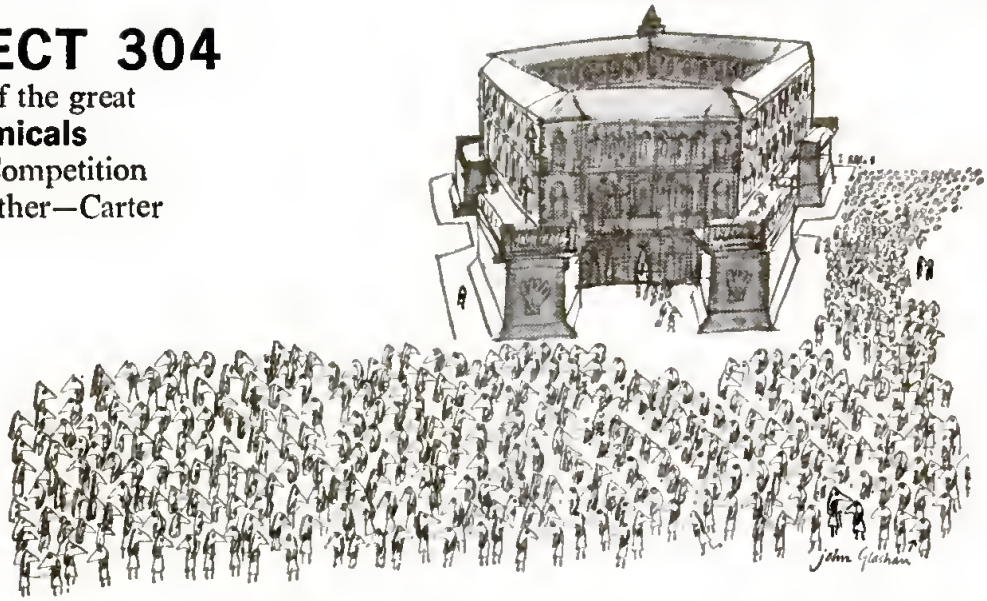
There are many other possibilities (in civil engineering, for example) which space does not permit to be discussed here. One can sum up by saying that sonar has a good future in the non-military field, but that intensified research and development will be necessary if its full potentiality is to be realized.

Of the 29 papers presented at the meeting 26 were preprinted in two bound volumes: some extra copies are available for purchase from the Inst. I R E., 9 Bedford Square, W.C.1. Price 52s 6d.

FIGURE 5. *Record obtained with 3-beam echo-sounder. (Courtesy, Institute of Navigation.)*

PROJECT 304

The story of the great
Shell Chemicals
Sculpture Competition
by A. N. Other—Carter

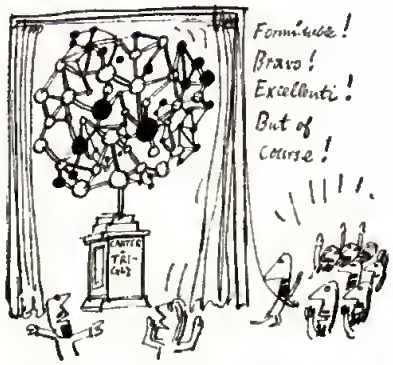


Chapter Twelve: Carter's Double Prize

Announcement Day was a great occasion, and I am bound to say a bit poignant for me; not only because this meant perhaps the end of those gay Chelsea parties with witty sculptors, a return to the old routine of writing pamphlets about careers in expandable polystyrene (for moulding and insulation work), or Epikote epoxide resins, or seed dressing and horticultural sprays. There was, also, Isobel.

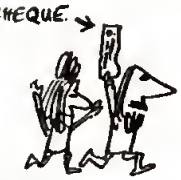
As I looked down from the windows of the 57th floor of the Resins Building, where so many months ago Mr. Carter, one of our directors, had outlined his scheme for the sculpture competition for *The Spirit of Shell Chemicals* I saw a gay scene. Mr. Carter had declared a holiday, and except for essential maintenance staff at Stanlow, Cheshire (solvents, intermediates, detergents, resins, sulphuric acid etc.), Carrington near Manchester (polyglycols, plastics, toluene) and Shell Haven, Essex (agricultural, and detergent alkylates) *everyone* was there, chatting on the flower-decked lawns round the Exhibition Marquee where the winning sculpture awaited unveiling. I could make out Carter from Ketones, Carter from Polyolefins . . .

A familiar voice murmured at my ear. 'I think we'd better forget Paris, A.N.' She was right. That was another time, when we were both young sculpture students. Now I was happily settled at Shell Chemicals, with a house and three lovely children at Sidcup. And Isobel . . . 'so you see,' she was saying, 'Waldo is a scientist of genius *and* a brilliant sculptor, and we . . .'



Waldo! So that was how she spoke of Carter from Triethylene Glycol!

Sure enough, when punctually at 3 Mr. Carter unveiled the winning exhibit it was *Waldo's* molecular model of that substance, a dynamic swirl of the carbon and hydrogen clusters at the heart of our world. 'Our distinguished judges,' said Mr. Carter, 'Cosmo Fanlight, TV panelist and articist, Benson Benson the famous non-sculptor and author of *Negative Form*, and Professor Hugo O'Bapchild, the famous Irishman, are unanimously agreed that no sectional representation of our many activities could so clearly express the real *us* as does this abstract yet supremely practical and beautiful form, one of the basic structures underlying our aids to a hundred industries from paint-making to engineering, dry-cleaning to fruit-farming. So I now call upon Waldo———er, *Mister* Carter (laughter) and his charming fiancée, Miss Isobel *(prolonged cheers)* to accept this cheque . . .'



THE END

But of course there's no end to **Shell Chemicals**

For any information about chemicals contact the Information Officer, Shell Chemical Company Limited, 170 Piccadilly, London W.I.

Automation in laundries

A prototype machine shown this week at an exhibition in London can carry out automatically the whole process of laundering flat articles such as sheets. Future possibilities include extending the technique to tailored garments, and the automation of other processes in the industry

by Jack Leicester
Director of Research, British Launderers' Research Association

THERE is no lack of problems in the apparently simple process carried out in a laundry. Removing dirt from soiled articles satisfactorily is really a complicated operation and has taken the British Launderers' Research Association into such realms as the structure of textile materials and chemical engineering. Nevertheless, the most urgent task to be done is to reduce the wastage of labour. Present-day laundering is a batch process and the articles are handled many times in their progress through the laundry. Launderers are faced, like almost everyone else, with a labour shortage and rising costs, and the situation could eventually lead to the industry's being brought to a halt by a lack of people willing to work in laundries or pricing itself out of business because of rising charges. Washing machines, now a commonplace in the home, provide more competition and make the difficulties of the launderer more acute.

The solution to these problems is to develop automatic machines that will carry out the whole of the laundering process on flow-line principles and produce finished articles of at least equal quality to that obtained by conventional plant. About four years ago, the BLRA began to work along these lines, the research being supported by a special grant from its members and also by a grant from the National Research Development Corporation. A prototype machine which is the result of this research is being shown this week at the Laundry, Dry Cleaning and Allied Trades Exhibition at Olympia, London. Working at a speed of 35-40 ft per min, it accepts soiled laundry at one end and at the other produces clean and finished articles, semi-folded. The machine is a major step towards the automation of laundries, and opens up the prospect of greatly increased productivity per operator hour. It handles only flat articles—sheets, pillow cases, towels and so on—but as these make up 70 per cent of the normal intake of a laundry, commercial development of the machine should not be inhibited by this.

In laundries there are three main actions to carry out. Soluble dirt, such as fats and oils, is removed by a detergent mixture in hot water; insoluble dirt is removed from the spaces in the fabric weave by the mechanical movement of the washing machine; finally, alkali left in the article is rinsed out by clean water. Usually, the washing is put into a rotating cage and is tumbled through the detergent mixture as the cage rotates. The efficiency of this process is limited by the fact that, over a certain speed, the load is thrown against the cage by centrifugal force. At this point, the washing action practically stops. Dirty water is replaced with clean until the sequence is completed and rinsing begins to leach out the alkali.

After this the washing is placed in a hydro-extractor, which is similar to a household spin-dryer but which spins much faster and gets more water out. The articles are then dried, usually in another spinning cage with a current of warm air blowing through it, and passed through a calender which has a polished bed in contact with a number of rollers, both bed and rollers being steam heated. The rolls are covered with resilient fabric padding to obviate damage to the article. (Shaped articles such as shirts cannot, of course, be calendered. They are dried on presses.)

How much labour these operations demand can be imagined, with machines continually being loaded and unloaded.

The individual steps in laundering—dissolving, agitating, leaching and drying—are similar to chemical engineering processes, and we started out at the BLRA to apply a chemical engineering approach to the problem. The machine which we have now constructed works on the counter current principle, the articles moving in one direction and the rinse and wash liquids moving in the other. Articles come into contact with cleaner and cleaner water as they progress through the machine until they leave the last rinsing section.

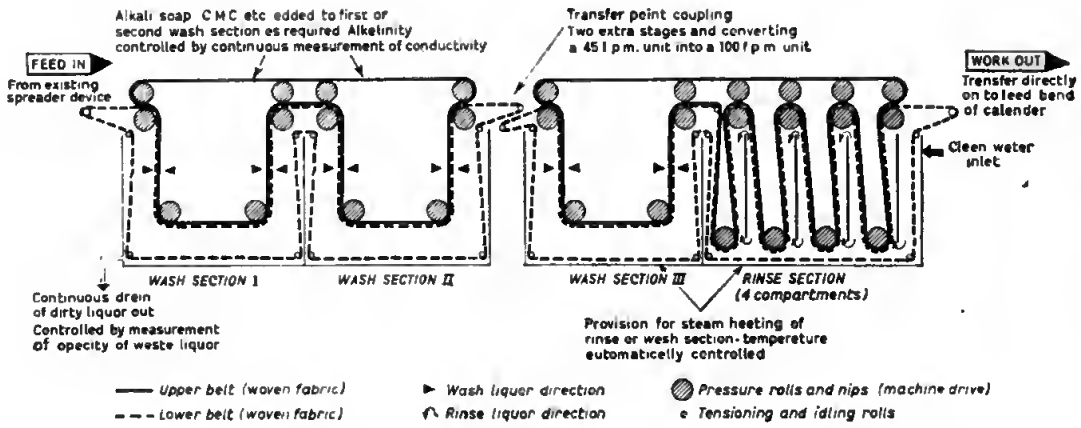
We have designed a belt guidance system which carries the individual article through the machine and ensures that it is is thoroughly washed and rinsed. Dirty laundry is fed into the machine flat, in the same way as it would be through a domestic wringer. This can be done by hand in small laundries where the speed of operation would not have to be high, but it could be done by machinery in larger ones. Equipment for this operation already exists.

An article first enters a washing section, where it meets jets of high-velocity water and detergent. The turbulence in this section is extreme and at first foaming was a difficulty which we had to overcome by the use of a "tailor-made" detergent. In the prototype machine the tanks of the washing section have been made of stainless steel to avoid any problems with undesirable chemical reactions, but there is no reason why materials such as fibre glass should not be used in any commercial version. During its passage through the wash, the article is squeezed by pressure rolls to help removal of dirty liquid from the fabric. The washing section is built in compartments so that the dirtiest wash water is used only for pre-washing the incoming work to get off the worst of the soiling. An opacity-measuring instrument is fitted to this section of the machine and, to keep suspended dirt at an acceptable level, controls a continuous bleed-off of dirty water to waste. Instrumentation of the machine, in fact, is quite simple and would present no "headaches" either in operation or maintenance to the average laundry manager, who would merely have to see that his staff kept the indicators on the instruments controlling the alkalinity of the wash liquor, its temperature, level and turbidity, between certain limits.

After leaving the wash an article goes into a transfer section, where it is picked off from one set of belts and led on to another pair. The reason for this is perhaps not obvious. We have put in a transfer section so that the size and speed of the machine can be varied according to what

Automation in laundries *continued*

Schematic view of the experimental continuous processing machine. Overall dimensions: length—16 ft, breadth—2 ft 6 in., height—5 ft 6 in. The speed range is 35 to 100 feet per minute.



a laundry requires. A small laundry will clearly not want to have a machine working at the speed and productivity that a larger one will need. As a complete machine can be built up of a number of units connected by a transfer section it can be designed to fit into any size of laundry. Capital costs are kept down by this and the machine's advantages are made available to the small business.

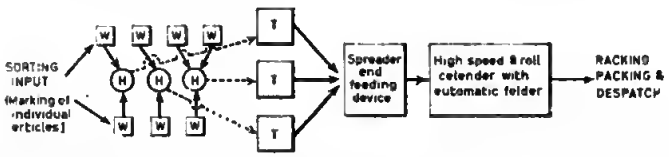
From the last washing bath an article is carried into the rinse section, still moving in the opposite direction to the flow of rinse water. Its speed through the rinse bath and the rate of the flow of water, which is controlled, set up enough turbulence to rinse it thoroughly and, in addition, it is passed through a number of nip rolls which subject it to alternate squeezing and re-wetting. At the end of this section there are pressure rolls which remove sufficient water from the article so that it can be presented directly on to the feed bands of a conventional calender or ironing machine for final finishing and drying. If necessary, an extra heated roll can be introduced at this point for additional moisture removal. At the Exhibition we are demonstrating this part of the operation by a small handkerchief ironer only, and there is no automatic folding of articles. Machines to do this, however, are available commercially and they would certainly be necessary for operating at high speeds.

The belts used in the machine have to carry and maintain the articles flat throughout, whether they are travelling horizontally or vertically, and they must be made so that they do not hinder washing, rinsing or pressure squeezing. We have had to pay special attention to their construction to ensure that even the most delicate fabrics are not damaged in their passage through the machine. Damage to fabrics is probably the most common complaint against laundries, not always well-founded, and we have had to make sure that the continuous process does not offer an additional cause for criticism.

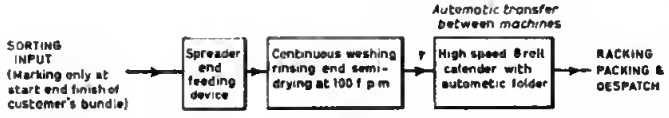
Our experimental machine will process articles up to 20 in. wide. This would not be an economically sized unit to operate in practice, and to get some idea of the productivity obtained by continuous laundering in comparison with that of conventional laundry machines a theoretical assessment has to be made. With a machine 120 in. wide (the size a laundry would want), output would be around 350 lb dry weight per hour at a running speed of 30 ft per min. If speed were increased to 100 ft per min, output would go up to about 1,250 lb per hour. To obtain the lower output, a conventional laundry would need two or three washers, according to capacity, one hydro-extractor and one tumbler drier. To obtain the higher output, there would need to be six or seven washers, three hydro-extractors and three tumbler driers. Savings in manpower are quite large. For the higher output the continuous machine, including calendering, would require 6 operators, whereas the conventional plant for the same output would need 10 operators, a reduction of 40 per cent. The cost of a machine will naturally depend on its size, but most of them should work out in the £18,000 to £40,000 range, a figure within the resources of most laundry firms.

These are not the only points in favour of the continuous machine. On the average, the time an article is in the continuous machine is about 45 sec and so wear is cut down to a minimum. At the BLRA we have washed test pieces, soiled to the same degree, in both ordinary laundry machines and the continuous one, and we have always found that the continuous process produces a better result. This, of course, does not apply to such things as coffee and tea stains, which are impossible to remove except by bleaching and, in fact, are bleached out in conventional laundering. As yet we are not able to include bleaching in the continuous process, and research into ways of doing this will form part of future work at the RA.

There are still more problems which must be tackled in the extension of automation to laundries, even if the commercial development of the present machine goes without a hitch. On the washing side, there remains the 30 per cent of articles which are not flat—shirts, jackets and so on. These would have to be washed on a form of some kind and dried by jets of heated air from the inside. This is difficult to accomplish, but we shall be going on to look at the possibilities.



Laundry layout using conventional plant and handling 1,250 lb dry weight of flat work per hour. Plant required: seven 100 lb washers, three 100 lb hydro-extractors, three 100 lb tumbler dryers and 1 eight roll calender with aid to feeding and automatic folding.



Laundry layout and plant required for the same weight of work in above, when continuous processing is employed.

Science in British Industry

Protecting jetties with hydraulic fenders

A NUMBER of experiments have been made in recent years with soft fenders to diminish the movement of moored ships which are subject to the action of waves. A new kind of fender, in which pneumatic and hydraulic principles are jointly applied to absorb energy and protect jetties from impact, has just been tested at Dover. It is a cylinder of rubber cloth, closed with a dome at the upper end, open to the water at the bottom and held tight vertically by weights around its skirt. Uncompressed it is filled to about three-quarters of its height with water; under pressure from a hull, about half the water is forced out from the skirt and air from the dome comes down to fill the space.

The device was designed and made at the Hydraulics Research Station at Wallingford, Berks. It was first tested at the station in model form and appeared then to reduce the amplitude of a ship's motion by a factor of 2 to 8, depending on the stiffness of the mooring ropes. Recently, full-scale tests were made at Dover with a fender of this type about 9 ft 6 in. long and 2 ft 8 in. in diameter. This was intended to be suitable for use with ships up to 50,000 tons displacement.

Three such fenders were placed alongside the eastern arm of the breakwater inside the harbour and mooring tests with big ships gave reasonably close confirmation of the model tests. Development work is continuing and fenders of still bigger dimensions are likely to be prepared.

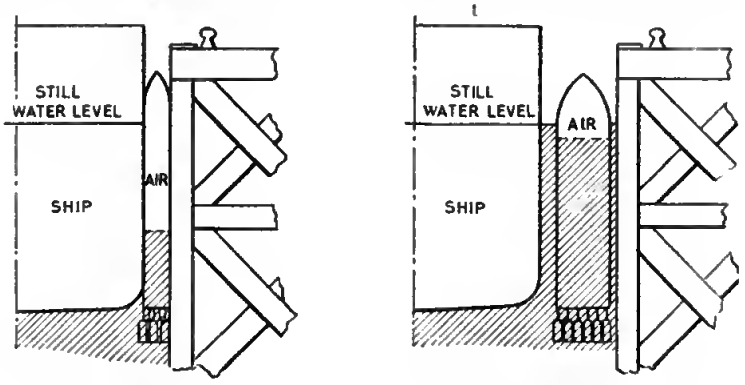


Diagram of the hydro-pneumatic fender in position at a jetty.

Cleaning beet

FARMERS WANT clean beet in two places, first in the field when it is growing, and, secondly, in the lorries taking it to the factory for processing. Control of weeds in the field is difficult, as chemicals sprayed after beet seedlings have emerged are likely to damage the crop. Contact herbicides can kill any weed seedlings emerging before the beet, and will work with rapidly germinating weeds like charlock, but knotgrass and chickweed can still be a problem as they germinate slowly. Soil-acting herbicides applied a day or two after sowing kill any weed seedling for a time, but their effects vary with soil moisture, soil type and tilth, and the dosage must be carefully adjusted to avoid damage to the crop. Though IPC and IPC/Enotbal mixture can be used in this way, keeping the beet fields clean is still a problem for the farmer.

When the beet is harvested and sent to the factory, the contracts usually specify that it shall be as free as possible from soil, but the adoption of mechanical loading devices such as fore-end loaders on tractors, especially from clamps on the ground, has resulted in larger quantities of dirt and rubbish being loaded, ranging up to 55 lb or more per cwt.

To tackle this problem several types of clean-loader have been designed which clean soil from the beet by vibration. They have been shown to reduce the dirt loaded by 50-60 per cent on heavy soil, and by over 80 per cent on light soil. On light land the initial dirt tare ranged from 34.1-45.4 lb per cwt, and after cleaning it was reduced to between 4.0 and 7.2 lb per cwt. On the heavier soil the initial dirt tare was much the same, and it was reduced to between 9.1 and 17.5 lb per cwt. Wider use of these machines would not only reduce haulage costs, but also cut losses caused by factories refusing dirty loads, and many haulage contractors are now using them as a matter of routine.

Sticky-back ceiling for cars

AN ALTERNATIVE to the familiar fabric lining for the roofs of saloon motor-cars is at present being given tests by the industry. It consists of a plastic or mixture of latex and plastic laminate in the form of a thin film which is sprayed with adhesive and stuck directly on to the frame which forms the roof of the car. The method of spraying the adhesive and applying the film has been developed by Dunlop.

Two particular advantages are likely to derive from this idea, if it proves acceptable as an alternative. One is that time will be saved on the body trim work in assembling motor-cars. The other is that something like an extra inch of headroom will be provided in saloons. With the present fabric ceiling there is usually an inch between the frame and the material. The system is also expected to have a number of other applications where big surfaces have to be bonded together.

Containing the sky

HOW TO plan buildings so that they shall make fullest use of the available average daylight is a problem that can be dealt with most satisfactorily if models can be placed in a steady light envelope, and there modified or otherwise experimented with. Getting a steady and unchanging quality of light for such tests has proved a difficult matter. What has been sought is an artificial sky in the form of a dome, so lighted internally as to reproduce the light that comes from an average overcast sky. The Cambridge School of Architecture has just erected a structure of this kind which seems likely to afford just the conditions architects need for testing quite big models.

It is a dome 18 ft high and 30 ft in diameter, built up of aluminium triangles coated inside with polyurethane foam insulation. These are assembled on a number of struts and ribs. The whole rests on a concrete base and access to it is by an underground passage so as not to break the artificial horizon with a door. The fluorescent tubes are set along the ribs of the dome, meeting at the apex, and their power is gauged to reproduce the light of an average overcast sky. The test house was designed by Mr David Croghan under the supervision of Professor Sir Leslie Martin and the structure was made by Unistrut Ltd., Welwyn Garden City.

This is the first test house of the kind in the world, the project being financed by the Nuffield Foundation. With its help, architects should be able to check their ideas of how deep rooms can be made, what height ceilings should be, what space relationship one building can be made to have with others and a great many detailed points affecting windows and lighting generally.

Particular care has been taken to keep the measure of the light constant. Within the 7,000 cu. ft of this structure, some 16 kW of power is being constantly dissipated while the lighting is switched on. This means a certain rise in temperature which affects the light output. An electronic voltage control has therefore been included to keep the illumination constant.

Towards the continuous brew

AUTOMATIC CONTROL of specific gravity and rate of flow seems likely to be introduced before long into the brewing of beer. An instrument to measure the gravity of a liquid, with this prospect in view, has been developed by the Sperry Gyroscope Co. When linked with a flow meter and controller it can adjust the gravity of a mixture by letting into the flow a greater proportion of the heavier or lighter constituent by comparison with a pre-set value.

Basically the gravity meter is a beam balance. The sample liquid is passed through a U-tube mounted on a cross-leaf suspension to constitute the mass of a conventional balance. A calibrated mass serves as the reference weight and can be adjusted to the required standard. Any error in the mass of the sample causes a displacement of the beam. This is detected electrically and a corresponding signal, passed through a transducer, produces an equal and opposite force which shows on a meter and can be communicated to the flow controller.

This is specially designed for controlled blending. One liquid is passed through a venturi tube which has a valve in its side through which the second liquid is admitted. The flow of the second liquid is controlled by a ball valve operated by a solenoid which is energized by a multivibrator of fixed frequency but variable mark-space ratio. That ratio is controlled by signals from the gravity meter.

Tentative plans by the brewing industry were responsible for this development. They arise from proposals to replace the present system of brewing beer in vats by a new one described as continuous brewing. The impulse was provided by the high cost of space in big cities to house the succession of vats through which the beer passes during the brewing process. With continuous brewing, the planners claim that four times as much beer can be brewed in the same space. If it is adopted, the system will demand continuous control of specific gravity.

Interest has been shown in the new instrument by the paper industry as an aid in preserving accurate mixes of pulp supplied to the beds, and also to control the composition of china clay slurries for paper glazing. It is being considered by makers of soft drinks as a means of maintaining a steady mix of carbonated water and syrup. The instrument may also have an application in the preparation of explosives, in controlling concentrations of nitrocellulose in water.

The endless cure

IF RUBBER can be vulcanized by passing it through the oven as a long extrusion on a sort of conveyor belt, instead of cutting it up into small strips for curing, a good deal of labour and cost can be saved. A device which makes use of the fluidized bed technique, now finding increasing use in industry, has been under examination recently at the laboratories of the Rubber and Plastics Research Association at Shrewsbury, and is reported on favourably enough for several firms to have adopted the system, although improvements on it are contemplated.

The fluidized bed is now familiar. This particular one employs tiny glass beads which "float" on a stream of air passed through porous tiles in the bottom of the bed. Its merit is that it can support a substance without exerting heavy pressure on it. This was seen as an admirable way of handling the soft, flabby rubber compound while it is being turned by vulcanizing into the firm, tough finished product. Hitherto, it has been so difficult to deal with long pieces of rubber without pulling them out of shape, that the method of cutting it into strips for curing has had to be used.

Now, the soft material can be led continuously out of the extruder into the fluid bed of glass beads and allowed to float through it, curing as it goes. The time it spends in the curing oven is varied by lengthening or shortening the bed. In the early versions, the fluidized bed was arranged horizontally in the oven. This somewhat limited the range of rubber compounds which could be subjected to the continuous vulcanization process. The latest version is a very narrow vertical bed 30 ft high. The extrusion is passed through the bed from bottom to top. The bed is designed to produce high quality, non-porous grades. With either version, arrangements can be made to coil up the finished product at the end of the process. Marked economies are expected from this improvement and in due course their effect should be felt in the motorcar, aircraft, shipbuilding and domestic appliance industries.

Lamps oust the cathode ray tube

Red and green lamps replace the cathode ray tube in this simplified ultrasonic go/no-go instrument for measuring thickness or detecting and locating flaws.

THE FAMILIAR cathode ray tube screen is replaced by a simpler and cheaper system of indicator lamps in a novel approach to routine ultrasonic thickness measuring and flaw detecting. The instrument, called the Sonatest TE/3, is designed for use by unskilled testers, since it requires no interpretation of a trace. Instead, the existence of a flaw is indicated by a lamp that lights up. How far the flaw is from the surface can then be read directly from the scales of the instrument. Similarly, thickness of material can be measured ultrasonically.

The controls are divided into two main groupings, one on a red background marked "test zone", the other on a green background marked "check zone". To measure thickness, the instrument is first adjusted for zero error in the probe. The probe is then pressed against the component and coarse and fine "check zone" controls advanced until an echo from the far side of the component illuminates a green lamp. These controls are calibrated to give a thickness reading directly.

When looking for flaws, the green lamp continues to confirm that an echo is being received from the far side of the part while the probe is moved over its surface. Should the existence of a flaw interrupt the ultrasonic beam, however, a red lamp will light up. Its depth is then ascertained simply by adjusting the "test zone" controls until the red lamp is extinguished.

The Sonatest TE/3, available from Research and Control Instruments Ltd., London, wc1, can be used on mild steel up to 12 in. thick, and "test zone" controls can be adjusted in steps of 0.1 in., and are calibrated to ±1 per cent. Continuous adjustment can be made on the "check zone" controls, to make thickness measurements within 2 per cent. The instrument weighs only 18 lb and can be supplied for battery or mains power supply. It can also be linked to a remote flaw indicator, or used to operate servos for an automatic control or recording system.

MONSANTO CHEMICA

Foam to stop the Daily Mirror ever getting stuffy

Newspapermen work best in shirtsleeves, whatever the weather. And for Daily Mirror people that's fine. One of the things that makes a big contribution to good working conditions in the new Daily Mirror building is foamed Polystyrene. 41,000 square feet of it has been used for insulation in the building's giant heating and ventilation system. Foamed Polystyrene is the newest material to be applied to the problem of insulation. It has exceptionally low conductivity. Is easy to handle. And since it works on the air-bubble principle, it weighs astonishingly little. Headline news for the building industry!

FOAMED POLYSTYRENE is made from Monsanto 'Montopore'

If you as a manufacturer are interested in chemicals or plastics it will pay you to get in touch with Monsanto.

Foamed polystyrene insulation board was supplied by Flamingo Foam Ltd. and Poron Insulation Ltd., and installed by Falcon Insulation Ltd. on behalf of G. N. Haden & Sons Ltd. who were responsible for the design and erection of the heating, ventilation and air-conditioning services.

Montopore is a registered trade mark

MONSANTO CHEMICALS LIMITED
186 Monsanto House, Victoria Street, London, S.W.1,
and at Royal Exchange, Manchester 2.
Associated companies and sales agents in the principal cities of the world.

Monsanto

LS help bring a better future closer

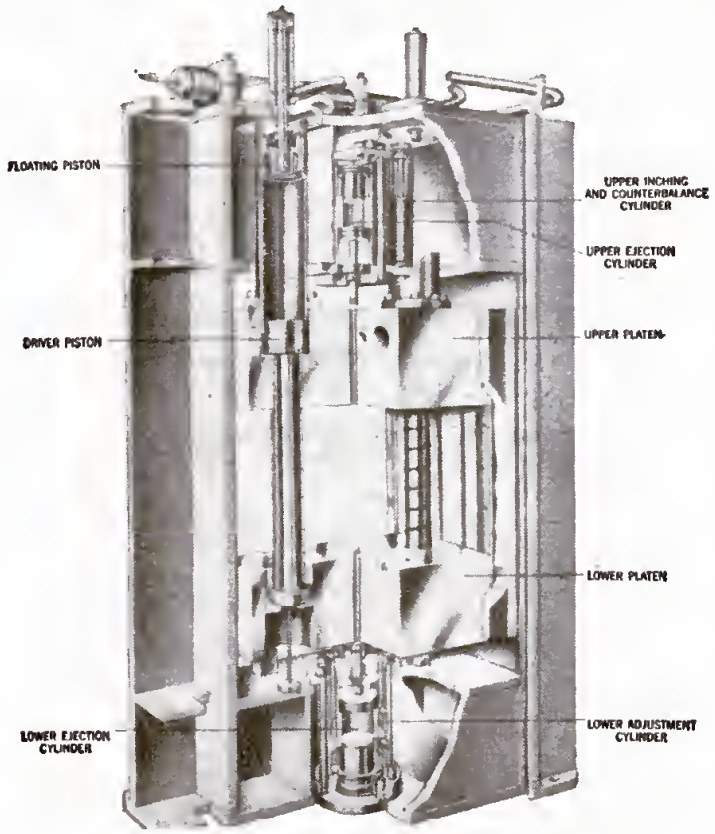
Science in Overseas Industry

UNITED STATES — New technique shapes metal in microseconds

A NEW FORGING technique that persuades metals as tough as alloy steels and titanium to flow plastically and assume the shape of a tool or die practically instantaneously has been demonstrated in Britain this month. The idea is to release highly compressed gas behind two 2.5 ton platens, to drive the platens towards each other at about 60 m.p.h. The gas is dry nitrogen, compressed by the action of the forge itself to 1,500 p.s.i., and it expands with explosive violence to form the hot metal in one ten-thousandth of a second. This compact forging machine, much smaller than its mechanical or hydraulic equivalent, is one of a range to be built in Britain by US Engineering Ltd., whose parent company US Industries Inc. already has several in operation in America.

Normal forging practice is akin to the time-honoured art of the blacksmith, in that it consists of raining hammer blows on the metal to change its shape. High energy rate forming techniques such as explosive and magnetic forming (see *New Scientist*, 26 April, 1962) and high-pressure gas forming differ radically from this approach because they move metal extremely rapidly and re-fashion it in a single blow. The several high energy rate forming techniques are each finding their own place in metalworking, but there are signs that the "exploding gas" method is the most versatile to come to fruition.

A cardinal feature of the new forge is the use of twin platens working in opposition. This means that the entire energy of the gas (145,000 ft lb in the case of the machine illustrated) is absorbed by the metal being worked. A thunderclap resounds as the forge is triggered but the vibration is not transmitted to the foundations; nor does the machine's frame, which is a welded structure, need to be specially reinforced. A 2,000-ton forge is said to have an efficiency of 83 per cent, and the cycle time for an entire forging operation is ten seconds.



Cut-away drawing of US Industries' high energy rate forging machine.

Meter gets scale it deserves

THE D'ARSONVAL galvanometer, with its suspended moving coil, is often assumed to have a linear deflection characteristic; that is, the movements deflection will be proportional to the current. In fact, this is not so. The flux in the airgap is not absolutely uniform in practice, owing for instance to inaccuracies in the radii of the pole tips and other dimensional errors. These errors produce departures from a linear characteristic, known as the "tracking deviation". Since meter scales for quantity-produced instruments are normally pre-printed the only difference, often, between an accurate meter and one of less precision is the care devoted to matching a scale to the movement. A choice of six scales, each deviating slightly from linearity, may be needed to calibrate an instrument to 1 per cent accuracy, and more to achieve higher precision.

To avoid this tedious hand-matching task, Hewlett-Packard Company, Palo Alto, California, have developed a system for automatically printing each scale individually to match the movement to about ½ per cent. Simultaneously, the calibration system provides a sensitive means of evaluating meter performance.

To calibrate an instrument, the assembled and encased meter, lacking only a scale, is mounted in a fixture and fed with a current which, in the absence of any tracking deviation, increases linearly from zero to full scale. The progress of the pointer is tracked optically, and any deviation from linearity is converted into an error signal which is fed back by a servo mechanism to adjust the current; at the same time the servo rotates a master scale through the corresponding angle. The servo in this way places each point on the master scale at its correct angular position at the time that point is printed down, so that the whole scale is matched to the peculiarities of the movement. Since, to function correctly, the calibrator requires the movement to function correctly, the calibrator by the same token provides a searching check on meter performance.

Promising seed dressing

PAC (phenacridane chloride), the parent compound of a family of fungicidal and bactericidal chemicals developed originally for medical purposes, is now being studied by the US Department of Agriculture as a plant disease controller. The intense indelible stain it leaves, which made it unsuitable for medical uses, is an advantage when the substance is used against seed-borne diseases of crops, for it acts as a convenient label, showing that the seed has been treated.

In laboratory tests at Beltsville, Maryland, PAC appeared to be more effective than the chemicals now in use to control disease organisms carried on the surface of plant seeds, and less liable to slow down the germination of treated seed. Once applied in the form of a solution in water (by soaking, dipping or spraying) PAC remained somewhat more firmly bound to the seed

surface than rival chemical seed dressings: after being washed in running water for 24 hours, PAC-treated tomato seed still retained its ability to resist a test dose of tomato leafspot bacteria. Although present evidence suggests that PAC is not hazardous or allergenic to human beings or animals, further tests are needed before its safety as a seed dressing can be assessed fully.

Fluid spring of many parts

A FLUID SPRING device developed for use with submarine missile launching tubes functions either as a shock absorber or as a rigid support, at will. Although produced for a specific application it has many other potential uses. For example, it could be fitted as a part of motor vehicle variable suspension systems which would adjust automatically to different terrains or road surfaces. The device has been developed at the Applied Physics Laboratory of the Johns Hopkins University.

The device is similar in principle to an ordinary hydraulic shock absorber, but in this case the fluid consists mainly of metal particles suspended in a silicone oil. This normally behaves like a medium viscosity oil, and the device then functions as a fluid spring. However, when a missile is to be launched, the stability of the launching tubes must be increased. The fluid is then electrically energized and the metal particles align themselves in the same direction under the influence of the magnetic flux which is produced. In consequence the fluid becomes a near-solid, with the consistency of potter's clay. This provides the rigidity needed for firing.

SWITZERLAND

Colourless burning

NITROGLYCERINE used in rockets and other military projectiles has to be dried after manufacture so that it responds instantaneously to percussion in use. The drying is usually done by passing it through a layer of sodium chloride or other inorganic material such as calcium chloride or potassium sulphate. Unfortunately traces of the salts remain suspended or dissolved in the nitroglycerine after drying and while these have little effect on its stability they impart a distinctly coloured flame to the exploding or burning material. This might help to locate a weapon in the field and though it may not be an important problem, it might have an effect on morale.

A chemist from Vaud has now found that water-binding substances containing no metal atoms, which are stable and inert when in contact with nitroglycerine and which are insoluble in it, are capable of removing the water, leaving the explosive to burn with a colourless flame. Urea is a suitable substance and when the wet explosive is passed through a basket filled with solid grains of it with diameters of 1 to 5 mm the water is completely removed. Previous attempts to use ammonium salts for drying were successful but their acidity made the nitroglycerine unstable.

GREECE

Overcoming water shortage by Dracone

AT THE END OF 1961, the first of two Dracones, each capable of carrying 500 tons of water, were put into service delivering water to the islands of the Cyclades group in the Aegean Sea. They had been ordered by Mr Peter Nomikos, who is connected with a Greek shipping line, after he had heard a lecture by Professor W. R. Hawthorne on the transport of liquids in bulk. Professor Hawthorne is the inventor of the Dracone, the flexible plastic containers which are towed on the surface of the sea.

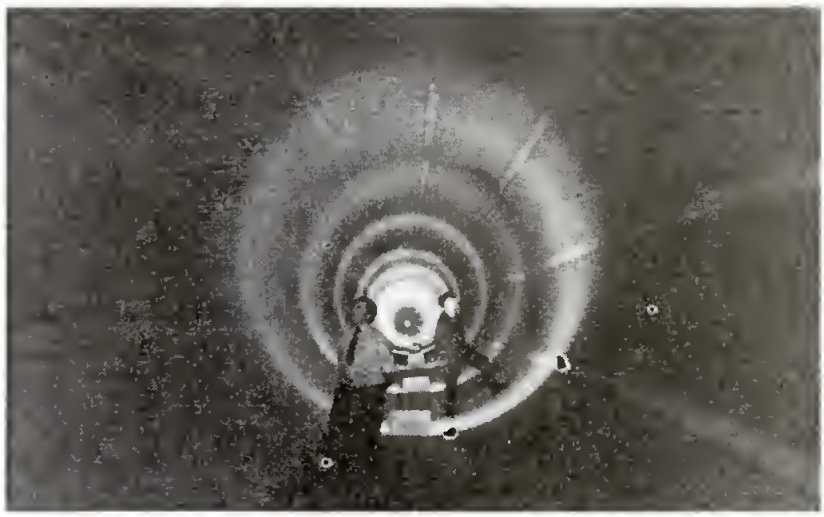
There are some 220 islands in the Cyclades and they have always suffered from a shortage of water which has limited the development of agriculture and the tourist trade. Mr Nomikos was familiar with the difficulties and in order to overcome them he ordered two Dracones to be made for him. They were neoprene-coated nylon cylinders, each 230 ft long. Up to the time of his order the largest ones were 100 ft long and could carry 40 tons of petrol or chemicals.

Delivery of water to the islands by means of the Dracones has apparently had a marked effect on their economy. From Santorini, the biggest island in the southern part of the group, reports on the island's main crop—tomatoes—say that it has increased tenfold, and from other islands similar figures have been obtained.

The Dracones were given special interior coatings to ensure that the water carried in them remained potable and this has led to supplies being made available to hotels catering for tourists. On one island, a hotel which had been forced to close in the middle of the season in 1960 because of lack of water now remains open the year round. On another island a new hotel has been erected.

When the success of the operation became apparent, steps were taken to increase the Dracone fleet. Two larger ones have just been completed in a hangar at Ringway Airport, Manchester, by P. Frankenstein and Sons Ltd. They are 300 ft long and each can carry 1,000 tons of water per voyage.

Water can be delivered by this system to any island in the group at an all-in cost of 5s. per ton—about a farthing a gallon—which is about half that charged for water brought by ordinary tanker. The experiment is interesting the World Health Organization and the Food and Agriculture Organization of the United Nations because of its possibilities in other areas of the world.



Inspecting the interior of one of the new Dracones.

USSR

Smooth skinned ingots

AFTER CASTING, the surfaces of steel ingots are often pitted and scarred and have to be machined before further processing. It has therefore become common practice to coat the moulds with lacquer, tar, resin or carbon to improve ingot skins so that rolling and forging can take place without previous grinding or chipping.

Another way of producing clean ingots is being used at the Bolsbevik and Izhorsk works. It employs no coating but, instead, uses magnesium as a way of excluding oxygen from the moulds so that solidification takes place in an inert atmosphere. When a group of ingots are cast together by the uphill method—the metal being poured into a central trumpet and fed to the mould bottoms simultaneously—the tops are tightly capped and magnesium chips wrapped in paper placed in each mould. When the steel touches the magnesium this bursts into flame and burns until all the oxygen in the space is consumed in the reaction. The steel is then poured in the usual way.

It has been found that 70 to 75 g of magnesium per ton of steel give the best results and, it is claimed, steels containing aluminium, titanium or chromium have shown considerably improved surfaces.

A scientific approach to university teaching

The process of education in universities is still largely amateur and instinctive. In several departments recently the traditional methods have been submitted to rigorous scientific examination and sometimes found wanting. There is now a considerable amount of knowledge from which a more rational arrangement of instruction could be derived

by Professor Miles Weatherall
London Hospital Medical College, University of London

At a time when higher education in Britain is being reviewed by the Robbins Committee, and the Hale Committee is paying particular attention to methods of teaching, it is worth considering how far there is any scientific evidence about the value of various forms of teaching.

University teaching has not always received as much attention as it deserves. It has less prestige than research, and appointments are made mainly on evidence of research ability. Training for university teachers is almost non-existent. Methods appropriate to university teaching are the subject of endless argument, mainly, perhaps, because so little is known about their efficacy. Primary and secondary education have long since become subjects of professional study, but the process of education in universities themselves is still largely amateur and instinctive. The teaching is often done well, sometimes splendidly, but the processes involved are worth more study.

Getting evidence about the effectiveness of different methods of teaching is anyway not easy. Teaching is a kind of interpersonal relationship, and what works in one group of teacher and students does not necessarily work in another. The results of teaching are complicated; few teachers aim only to instil factual knowledge, but the more generous aims are less definable and correspondingly difficult to evaluate. Investigation of atomic structure and chemical reactions must have appeared as difficult and confused to Avagadro and Gay Lussac. However, good evidence can always be obtained by experiments, and recently a variety of scientifically valid experiments have been made on university teaching.

The term "scientifically valid" requires stressing. An experiment without controls is not scientifically valid, but among publications on "experiments" in university education it is rare to find any inclusion of control observations in the proper sense of the term—observations made in a situation differing from the experimental one *only* by the absence of the factor being investigated.

However, experiments of this sort are quite feasible. A good example was provided about ten years ago by Dr Hannah Steinberg and Dr H. E. Lewis at University College London. The object of the experiment was to assess the value of showing a scientific film to medical students. Films are not essential to medical education; they are attractive, but laborious to make: does showing them to students produce any lasting benefit at all? To answer the question objectively, Steinberg and Lewis divided a class of medical students into two groups, and each half class was tested by a questionary on four occasions, separated by intervals of a week, two months, and again a few days. One group of students was shown the film between the first and second testing, and the other between the third and fourth, so that benefit from the film could be distinguished from "practice effects" resulting from repetition of the questionary and incidental learning from other teaching. Practice effects can be a serious difficulty in studies on learning; the mere act of testing provides an incentive to learn, and must be carefully controlled if it is not to interfere with the process being tested.

The questionary scores showed quite clearly that the film was useful in inculcating factual knowledge, but also brought out the point about testing, because the film had more effect in the students who had been tested three times before seeing it than in those who had had their attention drawn to its points by only one exposure to the questionary. This role of simple examinations as a means of initiating studies in a subject has not often been followed up; more evidence on its value would be instructive.

More recently Dr C. R. B. Joyce and I have examined more usual methods of teaching medical students. Lectures were

A scientific approach to university teaching *continued*

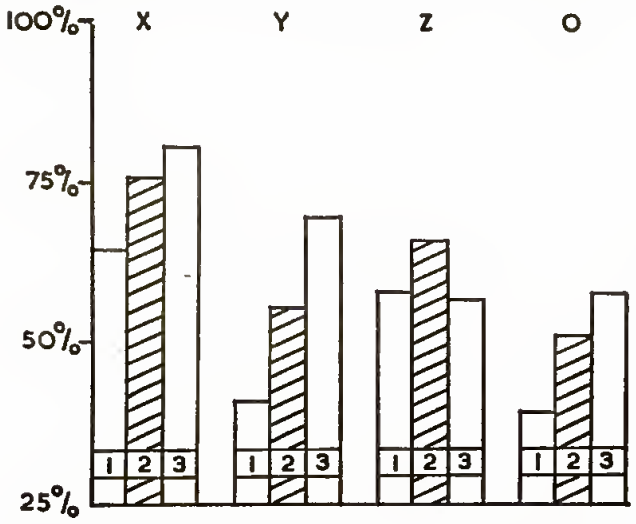


FIGURE 1. *Scores on three tests obtained by a class after lectures by three lecturers and without lectures on comparable topics. Lectures in these conditions were more valuable than the students' own reading, but considerable variation was demonstrable in the effectiveness of different lecturers.*

Subject	Topic I	Topic II	Topic III	Topic IV
Students: Group A	Reading	Lectures (W)	Practicals (Z)	Seminars (X)
B	Practicals (X)	Seminars (Z)	Reading	Lectures (Y)
C	Seminars (W)	Practicals (Y)	Lectures (X)	Reading
D	Lectures (Z)	Reading	Seminars (Y)	Practicals (W)

FIGURE 2. *Factorial arrangement of teaching experiment to permit separate evaluation of teachers, method of instruction, students and difficulty of topic. W, X, Y and Z represent the four teachers concerned.*

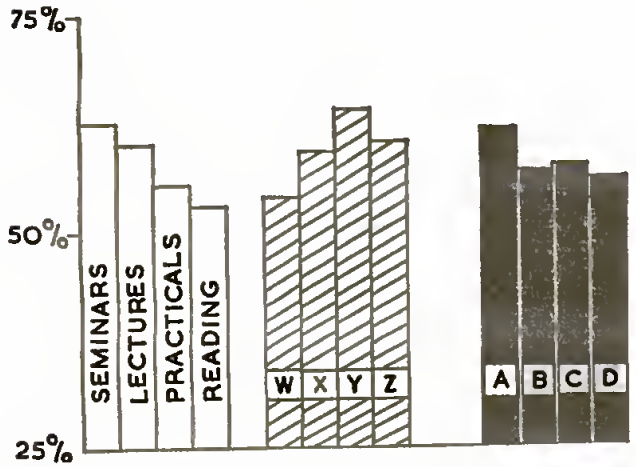


FIGURE 3. *Results of the factorial experiment shown in Figure 2. Combined scores of the final test analyzed according to method of teaching (open columns), teachers (shaded columns) and students (black columns). The groups of students differed between one another less than the effects of either different teachers or different methods of teaching.*

supposed by Samuel Johnson to have become obsolete with the advent of printing, but in spite of Caxton—and Johnson— they persist. Some objective evidence of their value is desirable, and we arranged a course accordingly. In this case, the subjective matter and not the student population was divided into control and treated parts. The control topics were not taught at all, though the students were advised what to read on the subjects, while the treated parts were presented in lectures by three different lecturers. The students were not tested initially; at the end of the course they knew more about the material taught in lectures than about what had been left to private study, and there were also, as Figure 1 shows, consistent demonstrable differences in the results of different lecturers.

The value of this experiment was limited because it dealt with only one kind of teaching, and it was followed by a more elaborate one which, unlike the first, certainly did not reduce the amount of teaching work done, and which was designed so that several factors could be investigated at once. To do this, both students and subject matter were divided in each case into four groups which were to receive different treatment. Four teachers took part, and the material was taught by lectures, by practical classes, by seminars (meetings in which a teacher stimulated discussion among students and aimed to minimize his own contribution) and by guided reading.

Each student studied different parts of the subject in different ways with different teachers, and each teacher taught different parts in different ways to different students, as shown in Figure 2. "Factorial" designs of this kind are invaluable for investigating situations where several variables interact with one another, and they have been used extensively in agricultural experiments on crop yields with different manurial dressings on land of varying fertility. In exactly the same way, efficient comparisons of teaching methods can be made on students of varying ability, and a single experiment of this kind gave highly informative results.

Notably, seminars came out best, though only a little better than lectures and, as before, material left to private study was least well assimilated. Teachers also varied in effectiveness: it was particularly interesting, but unexplained, that they did not come in order as before: Y was evidently better in the second course, whereas X's original success was clearly not maintained.

The advantage of seminars over other types of instruction confirmed a popular belief in their value, but also presented a problem of economics and logistics all too familiar to teachers everywhere. Although the point was not verified experimentally, it was clear that the 15 students per lecturer was near the upper limit for discussion groups in which most members participated, whereas there was no difficulty in serving 60 students by a single lecturer. Also, seminars lasted longer, so the small gain shown in Figure 3 was obtained at a cost of about a sixfold increase in teaching time.

University departments can rarely afford to improve their methods at such a high cost in staff time, and it is plainly desirable to find out what ingredient of the seminar is responsible for its advantages. Active participation by the student is a likely factor, in contrast to his rather passive role in lectures, and as students are apt to discuss more freely in the complete absence of a teacher, seminars conducted as before were compared with discussions on set topics which were initiated by a commentary recorded on tape and continued at the discretion of the group of students. This kind of teaching was accepted

freely and sometimes enthusiastically by the students, but did not come out well in the subsequent evaluation. Factual material provided on the tape for discussion and listened to, often several times, by the students was not retained as well as material handled in teacher-controlled seminars, so it appeared that this line of approach to economical teaching had a limited value.

These experiments are not unique in giving an unfavourable view of traditional practical classes. In 1954, a quarter of a class in pharmacology at Harvard was assigned to a project system of laboratory work, while the rest of the class followed the ordinary series of exercises. The students doing projects fared more or less well, depending on the particular project which they had undertaken, but what stands out from Dr Avram Goldstein's report of this study is that they were in no detectable way worse off for not having followed the conventional course of exercises.

Certainly neither the London nor the Harvard studies give much support for the orthodox and almost sanctified belief in the value of formal laboratory class exercises as a means of teaching science, and it would be nice if the adherents of orthodoxy either brought forward experimental evidence in its support, or abandoned their advocacy of such classes. Practical work is expensive in teachers' and students' time and in apparatus and supplies; much of it is remote from any genuine scientific experimentation and if it has negligible educational value it is high time that it is substantially curtailed.

There is room for many more properly controlled investigations into methods and organization of teaching. Even simple repetition of the experiments described in a new setting would be valuable in establishing what general validity they possessed. There are many other questions to answer. What is the optimum number of students in a seminar? What is the maximum number which can be handled with any benefit? What is the optimum duration for a lecture? Is the traditional hour right, or would half an hour, or two hours, be better? All these points can easily be tested by experiments.

The main difficulty (and it is crucial in all problems of education) arises in evaluating the results of teaching. Objective examinations have the enormous advantage of giving reproducible results and excluding the sometimes very large variation between the marks of different examiners. They are useful measuring instruments, but what they measure is rather limited, being mainly factual knowledge. They can be elaborated in order to detect ability to reason logically, but they give little or no scope for measuring how much a student can use the facts he has acquired (or can get on without the facts which are not necessary for his intelligence). Above all, their repetitive use promptly modifies the reactions which they elicit from students. This is an inescapable problem of psychological experimentation, but progress is difficult when yardsticks themselves alter the length of what they measure. The most urgent developments needed in this kind of research are better measuring instruments. Their development cannot be separated from, and gives a fresh sharpness to, the question "What exactly is university education trying to achieve?"

The changing map of Jurassic Britain

Research on fossil Cephalopoda (ammonites) stimulated by finds in East Anglia has filled a gap in the palaeontological record of North-west Europe, changing the geologist's map of Britain at the end of the Jurassic epoch—130 million years ago—and reviving ideas put forward by a Russian ammonite specialist in the nineteenth century

by Dr Raymond Casey
Palaeontological Department, Geological Survey and Museum

IN March, 1947, the fenland plains of eastern England suffered their worst flooding in recent history, and a new impetus was given the age-old task of draining and conserving these fertile lands. A bold scheme for fenland protection was embarked upon, involving the cutting of drainage channels across miles of East Anglia. This was the knock of opportunity for the geologist. Fossils hidden under the fenland soil and recently brought to light by the excavators have stimulated research at the Geological Survey that is reshaping the picture of Britain as it was 130 million years ago.

The clues were given by ammonites. These are fossil cephalopods that made for themselves shells of calcium carbonate modelled on the lines of that of the pearly nautilus which today swims the Indian and Polynesian Oceans. This has a planispiral shell rendered buoyant by internal division into gas-filled chambers. From their appearance in the Devonian to their extinction at the end of the

FIGURE 1. *Ammonite Marble, Marston, Somerset. A mass grave of Jurassic (Lias) ammonites, comprising 5 broods apparently killed at once.*

Cretaceous—a period of some 330 million years—the Ammonoidea were spread through the oceans of the world. Rock bands such as the Marston Marble of Somerset (Figure 1) show that at times they swarmed in the shallow waters of the continental shelf, their empty shells crowding the sea-bed. Evolving rapidly, they threw off innumerable short-lived genera and species, enabling the ancient sea-floor deposits which now compose much of the Earth's surface to be divided into narrow zones, each corresponding to a brief episode of ammonite history. The fact that they are easily recognized in the field and can be collected and identified without special equipment or laboratory treatment contributes greatly to their usefulness. No other group of organisms in the Upper Palaeozoic and Mesozoic provides a more finely notched yardstick for comparing the stratal succession from place to place, or a better means of investigating the former extension of seas over tracts now land.

But the restless movement of the seas around the continental margins which spurred the ammonites to evolve never gave them a full-term lease of any one place. Perfection of the ammonite chronology is thus a problem of space as well as time. Encouraged by the seeming indifference of ammonites to ecological barriers imposed upon many other organisms and by the possibility of wide dispersal of spawn and dead shells by ocean currents, palaeontologists in the past worked towards a single ammonite time-scale of world-wide application. Hopes of attaining this ideal have faded with the awareness that the seas of the Mesozoic Era were divided into provinces no less biologically autonomous than those of today.

So far as the Ammonoidea are concerned, differentiation into faunal provinces seems to have been progressive during the Jurassic. At the beginning of the epoch ammonite faunas were more or less universal; species from the Lias of Dorset can be matched in Alaska, Indonesia and Peru. By Middle Jurassic times some of the ammonites in Arctic regions had begun to branch out on their own and a separate Boreal realm took shape. Its definition was followed by isolation of Tethyan and Pacific realms. Towards the end of the Jurassic the Boreal realm itself broke up, with two main components centred on SE England and the Moscow region. This is thought to reflect large-scale shrinkage of the oceans at the end of the Jurassic and the beginning of the Cretaceous whereby communities of ammonites were cut off from each other and went their separate evolutionary ways. Integration of the various realms and provinces established at that time, each with its own ammonite succession and nomenclature, remains one of the outstanding problems of palaeontology.

Up to the time of deposition of the Kimmeridge Clay, Jurassic Britain was split into a number of islands (Figure 2) relics of which are seen today in the Highlands of Scotland, the Pennines, and the hills of Wales and the West Country. Eroded remnants of another such island, its westerly salient buried under London, break surface as the Ardennes of France and Belgium. The idea has long prevailed that over most of the British Isles the Jurassic marine record is cut off abruptly in the Kimmeridge Clay, and that the succeeding Portland Beds are preserved only on the southwestern flank of the London-Ardennes island. The final stage of retreat of the Jurassic sea and its ammonites from NW Europe was pictured as having left Britain high and dry except for the south-eastern corner of England. Here, in an environment of salt-marshes, fresh- and brackish-water swamps, the Purbeck Beds were laid down as the tail-end of the Portlandian. During this supposed missing interval in the marine occupancy of Britain a special ammonite fauna typified by the genus *Craspedites* flourished in central Russia. In southern England the freshwater regime of the Purbeck was carried over into the Cretaceous, by which time subsidence of the old Jurassic trough had made room for the deltaic sands and muds of the Wealden formation.

The returning sea was considered to have reached eastern England in Cretaceous times, after an absence of millions of years, spreading Speeton Clay, Spilsby Sandstone and Sandringham Sands over the denuded plains of Kimmeridge Clay. This important event was dated by the ammonites *Subcraspedites* and *Paracraspedites*. Originally described from the Spilsby

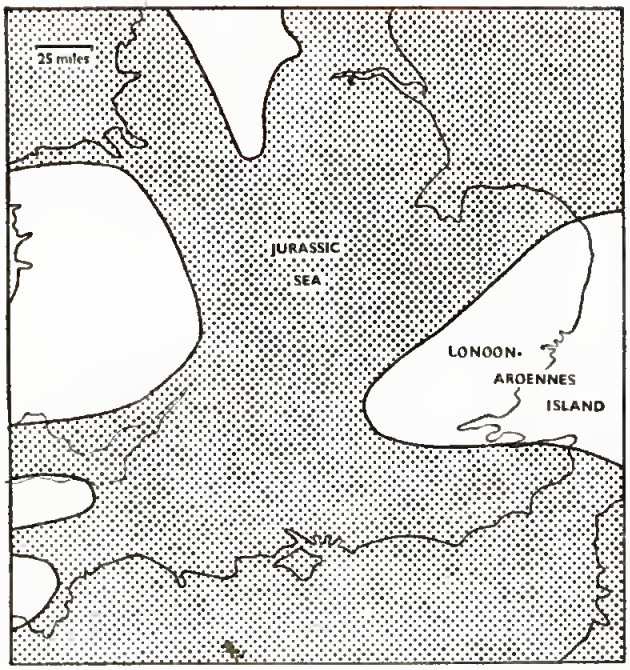
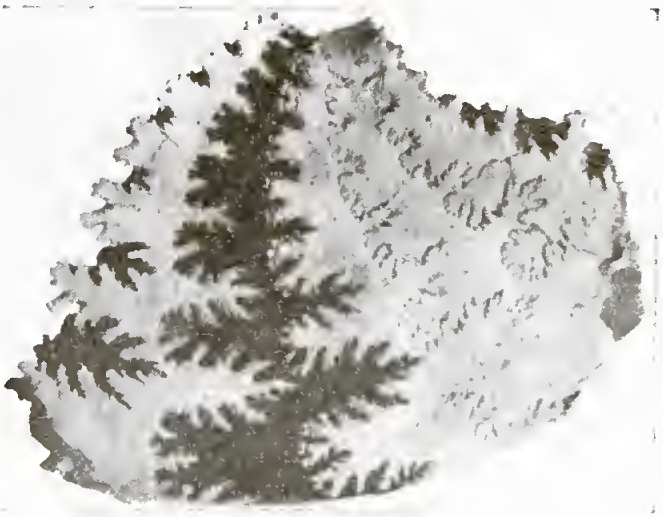


FIGURE 2. *Generalized palaeogeographic map showing principal land areas of England and Wales during the Jurassic Epoch (Lias-Kimmeridgian). Shore-lines were subject to fluctuation and altered drastically after the Kimmeridge Clay period.*

FIGURE 3. *Segment of* Hectoroceras *from the Sandringham Sands near West Dereham, Norfolk. A mould of the interior of the shell stained to bring out the pattern of the suture-lines.*



Sandstone of Lincolnshire, these two genera have since become the guide-fossils to the Cretaceous bed-rocks over the whole of the Boreal realm from Siberia westwards through Greenland to the Canadian Arctic. Their period of existence has been called "The Suberaspeditan Age".

A turning-point in the study of East Anglian geology and of the British Jurassic was reached in the winter of 1960-61. Scooping out a channel near West Dereham, Norfolk, engineers in charge of the Flood Protection Scheme exposed rich fossil-beds in the Sandringham Sands. Here, officers of the Geological Survey, who had the cooperation of the Great Ouse River Board and were keeping a close watch on the excavations, found abundant examples of the early Cretaceous ammonite *Hectoroceras*. Specimens were well preserved, many showing the suture-line (Figure 3). This is the line along which the gas-chamber partitions were cemented to the inside of the shell, its complex pattern being one of the aids to identification. No dateable fossils had ever been reported before from the Sandringham Sands and *Hectoroceras* had not previously been known to exist outside a small area on the east coast of Greenland. Full study of this important occurrence is being followed as a joint project with Dr R. G. Thurrell of the Geological Survey and Dr P. G. Larwood of the Geology Department of the University of Cambridge.

In the meantime, fossils brought to light from lower levels in the Sandringham Sands made re-examination of the ammonites from the Spilsby Sandstone, in the neighbouring county of Lincolnshire, a routine necessity. The results were unexpected. As demonstrated to the Geological Society of London and reported in its *Proceedings*, the key genera *Suberaspedites* and *Paracraspedites* were found not to be Cretaceous at all but Jurassic forms older than the Russian *Craspedites*. *Paracraspedites* turned out to be indistinguishable from the young of ammonites of the type common in the Portland Beds; in places it was collected side by side with such Portland genera as *Kerberites* and *Crendonites*, making it certain that Portlandian strata once stretched north to the vicinity of the Humber. *Craspedites* itself was found to be present in the Spilsby Sandstone, the upper part of which yielded genuine Cretaceous ammonites (*Surites*, *Tollia*) also new to Britain. Just as it is now clear that *Hectoroceras* was not a local evolutionary development isolated in Greenland waters, so we must concede that seaways were open at the end of the Jurassic for free communication between eastern England and central Russia. Possibly there were regular commuters between Spilsby and Moscow.

The new data from eastern England fits in with evidence from other sources that the change from Jurassic to Cretaceous time in the Old World was an unimpressive event. Commonly the boundary is arbitrary or falls in the middle of a sedimentary cycle and was not marked by volcanism and crustal upheavals of the magnitude that affected the Californian Sierras. It is because of its relatively uninterrupted record of marine life that North Americans look to Europe, especially Britain, for a time-check on Jurassic and early Cretaceous events. Reassessment of the Spilsby ammonites has thus corrected and amplified a unique standard of reference. Aside from the international significance of changes in the ammonite time-scale, the map of Britain at the close of the Jurassic is now transformed. Anticipatory signs of Purbeck conditions are seen in the top of the Portland Beds both in southern England and in northern France, and the passage from one to the other leaves no room to insert a theoretical equivalent of the Spilsby Sandstone. A similar continuity in the Spilsby Sandstone itself is shown by the overlapping ranges of craspeditid and Portland-type ammonites.

The inference is clear that the Jurassic sea never withdrew from Britain and that the Spilsby Sandstone is in part a marine equivalent of the Purbeck Beds. That similar ideas had been put forward late in the nineteenth century by the Russian ammonite specialist A. P. Pavlov is now almost forgotten. The student may read modern, exhaustive accounts of the British Jurassic System and be unaware of Pavlov's views, still less that they had at one time been officially adopted. In volume 5 of the Geological Survey memoirs on the Jurassic rocks of Britain, published in 1895, the Spilsby Sandstone is treated as a marine representative of the Purbeck Beds.

The changing map of Jurassic Britain *continued*

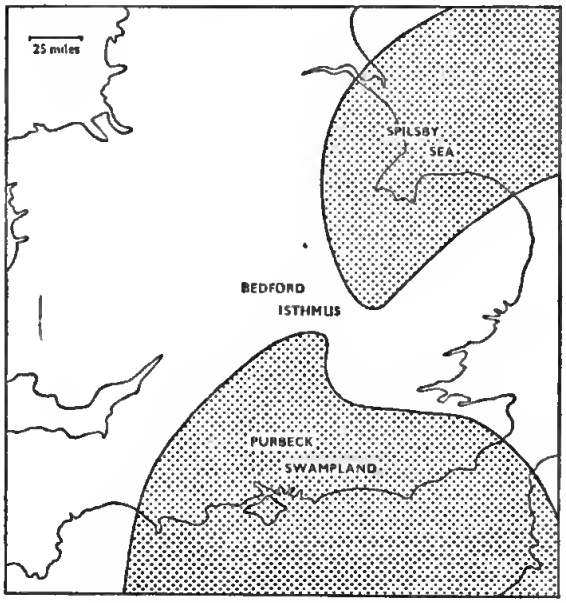


FIGURE 4. *Generalized palaeogeographic map of England and Wales at the end of the Jurassic Epoch.*

Table of strata showing position of the Spilsby Sandstone in relation to the geological succession in southern England.

	Southern England	Eastern England
Cretaceous	Wealden Beds	
Jurassic	Purbeck Beds	Spilsby Sandstone
	Portland Beds	
	Kimmeridge Clay	

Figure 4 shows in a generalized form the distribution of land and water over England at the end of the Jurassic, incorporating the hypothesis of a northern (Spilsby) sea contemporaneous with a southern (Purbeck) swampland. What little is known of the underground geology of East Anglia and the structural setting of the Midlands suggests that the Spilsby sea narrowed southwards, bounded on the southeast by the sweep of the London-Ardennes shoreline. Spilsby-type fossils found as pebbles in later deposits show that it extended at least as far south as Upware, near Cambridge. From a maximum of 560 feet under the heart of the Kentish Weald, the Purbeck Beds dwindle to a mere 20 feet in north Wiltshire and disappear altogether north of Aylesbury, Buckinghamshire. Nowhere is the Spilsby Sandstone known to exceed 80 feet in thickness and it shows every sign of deposition in a shallow, inshore sea. By contrast, 800 feet or more of Portland, Purbeck and Wealden strata were laid down in southern England during the same interval of time.

Intrinsically, the thinness of the Spilsby Sandstone is not a remarkable geological phenomenon: places in the Moscow Basin have only 20 feet of strata to show for the same time-span. In the present context it poses interesting problems of palaeogeography. Picturing the London-Ardennes island as the axis of a hinge with its southern leaf folding down more rapidly than its northern does not explain the inequality of sedimentary load which caused or helped to cause this movement in the first place. Did the rivers draining mountainous country to the north and west narrowly by-pass the Spilsby sea in their journey to the Purbeck-Wealden trough? More likely the Spilsby sea was a mere inlet of some larger reservoir—a proto-North Sea—which received the lion's share of the sedimentary quota.

A feature of the Purbeck Beds is the recurrence of so-called marine bands, marking episodes of sufficient salinity to support oysters and other euryhaline organisms. They had their maximum in the Middle Purbeck with oyster-banks reaching out along a front of 150 miles from Dorset to Kent and extended to the northern limit of Purbeck distribution. Although not marine in the strictest sense, these brackish bands show that undiluted sea-water was not far away. But where? A southern direction is usually presumed. But see how the new map (Figure 4) carries the eye to the "Bedford Isthmus" which must have been all that separated the Purbeck swamps and the Spilsby sea. Is it possible that this narrow neck of land, surfaced by newly emergent, unresistant Kimmeridge Clay and Portland Beds, was periodically breached by the sea from the north? Do the quasi-marine bands of the Purbeck give us the pulse of the Spilsby sea?

Recognition of a marine, cephalopod-bearing equivalent of the Purbeck Beds puts us within reach of a solution to one of the puzzles of Jurassic climate. This turns on the presumed disparity in temperature between the Portland and Purbeck regimes. That Europe was generally a good deal warmer in Jurassic times than at present is acknowledged. Though Britain formed part of the "Boreal" realm, this term should not be given its present-day climatic connotation. Rich floras of temperate aspect flourished near or within the Arctic, and coral reefs at times spread over parts of England. The Portland Beds are famous for their immense ammonites, a metre or more in diameter. By analogy with the giant shell-bearing molluscs of modern seas they must have lived in waters of considerably higher temperatures than those which obtain in these latitudes today. On the other hand, the water-snails of the Purbeck Beds are smaller than their living English counterparts. Together with the tiny insects, they have given some authors the impression that the Purbeck was a time of climatic cooling or at least of cold air currents on land. No one would claim that the reptiles that left their footprints on the Purbeck mud-flats (see *New Scientist*, 3 May, 1962, p. 234) were very small. And knowledge of present-day reptilian physiology and requirements makes it difficult to imagine the Purbeck dinosaurs and their allies, 15 to 30 feet long, as inhabitants of anything but a warm clime.

Here the work of Professor H. C. Urey, Nobel Prize chemist of the University of California, may find a new application. Professor Urey devised a method of determining the temperature of precipitation of organic carbonates by assaying oxygen isotopes which has been used with apparent success on belemnites. These are a group of fossil Cephalopoda with hard parts of calcite: they are rarely found in the Portland Beds, totally absent in the Purbeck Beds, but present in numbers throughout the Spilsby Sandstone. Belemnite sampling from different levels of this formation may well provide the means of answering questions of late Jurassic climatology in Britain.

It seems to me *by* Geminus

ON THE principle that any change must be an improvement, the patron saints of science and technology will have spent a cheerful week-end in contemplation of the new crew which has been chosen (by the same old skipper) to sail the Ship of State. At first sight there is even some tangible evidence for believing that this will be so. For is not Mr Maudling a man who served intelligently and sympathetically at the Ministry of Fuel and Power (as it then was) five years ago? And has not Mr Thorneycroft been the foremost supporter of development programmes for space rockets and for supersonic airliners? The Millenium, it may seem, is around the corner.

So far as Mr Maudling is concerned, it seems to me that these high hopes may be justified. He is as unlikely to behave with niggardly disdain towards the universities as to regard a tax on sweets and ice-cream as an instrument of constructive policy. For the first time in years we may be blessed with a Chancellor who can recognize that investment in educations ranks in importance with investment in steelworks and road transport. He may even be prepared to accept the doctrine of those like me who believe that education is not merely a means to an end, but an end in itself.

★

FOR MY TASTE Mr Thorneycroft is a less heartening supernova. To be sure, his reign at the Ministry of Aviation has been in many ways memorable for technology. It has witnessed two important schemes for carrying out major technical developments on a European basis. The more sensible of these is the supersonic airliner project, for which collaboration between British and French companies would seem to be a nearly ideal expedient.

Then there is the ELDO venture, in which Mr Thorneycroft, almost entirely by himself, has persuaded a number of European nations that an obsolete IRBM (Blue Streak) is really the ideal booster for putting satellites of all kinds into all possible orbits about the Earth. Such concern for the great wide world, a superficial judgment would suggest, can only be a virtue.

Unfortunately, however, I am jaundiced. In his zealous devotion to European causes Mr Thorneycroft has frequently used schemes for technical development as means to a political end. I have the nasty suspicion that if those imaginative fellows at the Ministry had been bent on building pyramids when Mr Thorneycroft took over, we should all now be committed to EPCO (European Pyramid Construction Organization), and to the maintenance of its proving grounds in the Arabian desert. In other words, it seems to me that Mr Thorneycroft has more enthusiasm for than judgment of technology. In a Minister of Defence, this is an unhappy combination.

★

THE MEDICAL Research Council has done well by the molecular biologists at Cambridge, though not before time. The new laboratory seems already to have had an uplifting effect on the souls of those who work there. People who, only a few months ago, spent a good part of their energy explaining why it did not matter to them that delicate experimental work had to be carried on in cramped military huts and that X-ray machines had to be stored in the corridors of Georgian houses, are nevertheless transformed characters, relaxed and more zestful than ever.

I cannot believe, for example, that there is any sense of regret at the move to a modern building in the heart of the man whose old office was so small that it was geometrically impossible for two people to sit down in it. But perhaps the most obvious mark of the exuberance which relief from deprivation has brought is the great model of the tobacco mosaic virus (TMV to the in-groupers) which adorns the new glass stairwell at Cambridge. Whatever Freudians may say, this has the virtue of identifying the new laboratory for the benefit of those who visit it for the first time, just as candles in windows used to guide fishermen back home.

★

THIS SAID, it seems to me that the collection under one roof of the galaxy of talent at the MRC's new laboratory brings to a head the whole future development of molecular biology. How is this new discipline to be spread among the other universities, if at all? How is it to be arranged that the new laboratory can recruit research students in substantial numbers without robbing other schools at Cambridge of what they consider to be their share of laboratory fodder? How is the development of molecular biology to be related to the teaching and the development of the classical parts of biology? These are questions which need urgent attention within and outside the academic world.

In my view the supremacy of the new Cambridge laboratory, both nationally and internationally, is so sure that steps should be taken to see that it is exploited. When things have settled down, in two or three years perhaps, it would be natural to expect that a steady procession of bright young men would move from the laboratory into university chairs all over the world, just as in the thirties men from the Cavendish Laboratory carried the doctrines of modern physics to the corners of the Earth. So that this can happen, the intake of research students at Cambridge should be drastically increased, even if departments of Micro-botany and Crypto-paleontology have to be plundered in the process.

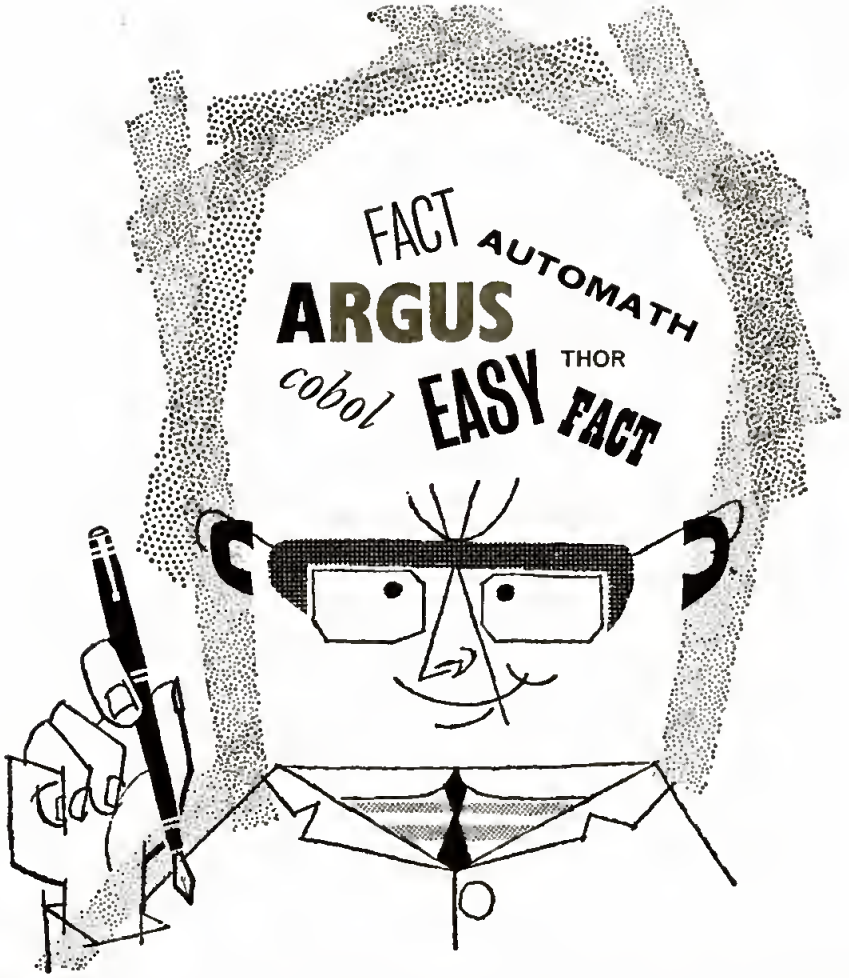
Finally, it must be recognized in the universities that teaching and research must be reorganized throughout biology. A great deal of current practice has now become as anachronistic as the survival of the doctrine of the aether into the Twentieth Century.

★

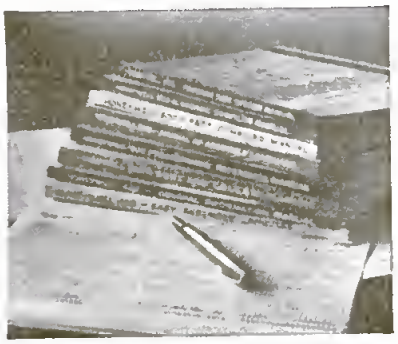
PUBLIC RELATIONS is a thankless job. "More kicks than ha'pence," they always say, and to make things worse, professional people won't accept that it's a profession. This is why I think it is worth calling attention to the stupified sense of success which must by now suffuse the public relations department of the War Office, fresh though it may be from the courts-martial on the Rhine.

For last week, with great daring and trepidation, the War Office allowed a busload of journalists to make a tour of the Microbiological Research Establishment at Porton Down in Wiltshire, where it has always been assumed that men in white nylon coats make ceaseless preparations to kill off half the population of the world with a single epidemic of anthrax or the like. By what I have been able to glean from my reading of the newspapers, the outcome of the visit has been to lay many of these fears to rest, and at the same time to give long overdue and much deserved credit to a group of scientists whose biological research is of the highest interest.

The moral here is plain, of course, and ought to have been appreciated long ago. Little is served by pointless secrecy except the exaggeration of people's fears and the distortion of the truth. In public relations frankness, as well as honesty, is the best policy. The Association of British Science Writers deserves some credit for urging that this principle should be applied at Porton Down. The War Office is to be applauded for recognizing that it could be done without disaster.



write English instead of Computerese



Hard facts about Honeywell software—and the 400, 800 and 1800 computers—available from:

Electronic Data Processing Division
Honeywell Controls Ltd
Moor House London Wall EC2
Metropolitan 9965

Special computer languags nothing. Not with Honeywell computers. Plain English, ungarnishsd—easier to follow, faster to work. How? FACT! FACT—one of many programming aids compilsd by Honeywell and now working for customers in Britain—simplifies programming for data processing. Plain English for automatic translation into machine languags. You understand, machins understands. Other simplified vocabularies? Certainly. There's ARGUS—works from mnemonics; AUTOMATH—like FACT, but scientific language; COBOL—the 'esperanto' of automatic programming aids, compatible with all computers; EASY—uses mnemonic codes and symbolic tags, includss built-in automatic error diagnosis. All aids for Assembly, Compiler and Operational Programs. All from Honeywell's Automatic Programming Library Routines.

Honeywell

Electronic Data Processing

Trends and Discoveries

Vacuum adhesion of clean metals

A METHOD OF metal welding that seems likely to become more important is that in which the two parts to be joined are automatically cleaned and pressed together in a vacuum. However, most of the experiments to investigate the process have involved pressures big enough to cause some distortion which allowed the surface atoms to come into the correct juxtaposition for the parts to adhere. In a paper read at the Fifth Annual Conference on Vacuum Metallurgy at New York University, T. Spalvins and D. V. Keller of the National Aeronautics and Space Administration's Goddard Space Flight Center, Maryland, described their studies of the adhesion of atomically clean metals under these conditions but with metal contacts that were nearly forceless. The subject, of course, has considerable significance for the selection of the best materials to withstand service in the hard vacuum of space.

The two metal samples to be joined in each experiment consisted respectively of a small plate and a thin rod. Both were annealed and atomically cleaned by bombardment with argon ions and electrons, and then magnetically brought together in a glass system under a high vacuum (2×10^{-9} mm mercury). The degree of adhesion was observed by the force on a strain gauge when the two parts were separated, and also by microscopic examination.

Pairs of metals between which the adhesion was complete included aluminium-iron, copper-silver, nickel-copper and nickel-molybdenum. Metal pairs that refused to weld were copper-molybdenum, silver-molybdenum, silver-iron, silver-nickel and germanium with germanium. From their results, the two workers conclude that such contact welding depends on aspects of the physical chemistry of the respective metals, such as their surface and interatomic bonding energies, rather than upon the purely mechanical conditions also proposed to explain the effect.

Ants' nests are warmer than surroundings

THE NINETEENTH CENTURY entomologist Huber was the first to suggest that ants which built mounds to house their nests could derive some advantage because the internal temperature might be more suitable than that outside. An entomologist from Chico State College, California, who has already discovered that the moisture content of ant mounds is more stable than that outside, has now studied the temperatures within the mounds of *Formica ulkei* (G. Scherba, *American Midland Naturalist*, Vol. 67, p. 373).

He found that the temperature inside the mounds was definitely higher than that of the surrounding soil, and fluctuated seasonally over a wider range. There was also a greater difference between the temperatures at depths of 5 and 30 cm than in the soil. Dr Scherba believes that his results support Huber's suggestion, and points out that in *F. ulkei*, which develops from egg to adult in one season, the higher temperatures will result in faster development. He also suggests that the various stages in development may thrive better at different temperatures, so that a wide gradient of available temperatures will be useful to the ants, the workers presumably keeping the eggs, larvae and pupae each in places with the appropriate temperature.

The differences between soil and mound temperatures occurred only during the warmer months of the year, and are probably a direct result of radiant heat from the Sun falling on the bare sloping face surface of the mounds, which are normally orientated to the south. The thick crust of the mound provides insulation, and the porous inner part, with a low rate of heat conduction and a low specific heat, becomes warmer than undisturbed soil. It is possible that the activity of the ants helps to warm the nest, but whether they regulate the mound's temperature by opening and closing its entrances remains unproven.

Is this how abnormal ground-water forms?

LAST YEAR the *New Scientist* (Vol. 10, p. 262) reported the discovery at Aqua de Ney, California, of a spring of unique chemical composition. Its water is very alkaline and contains large amounts of salts, such as sodium chloride, not usually prominent in natural ground waters. The discoverers, members of the US Geological Survey, surmised that Aqua de Ney water has undergone natural ion-exchange whereby sodium replaced calcium.

S. H. Wilson, of the New Zealand Institute of Nuclear Sciences, has now proposed an alternative explanation. He noticed that waters of somewhat similar composition occur in the hot-spring area of Rotorua, in New Zealand's North Island. Moreover, in certain parts of Tuscany and California drilling yields dry steam only. This steam probably boils off from underground chloride water at such a depth that the water is near its critical temperature (above which it would form a gas however great the pressure). The evolution of steam under these conditions may well leave water of the Aqua de Ney type, but it might rarely arrive at the surface. (*Geochimica et Cosmochimica Acta*, Vol. 26, p. 519.)

Bears that bit the dust?

BIOLOGISTS AT the University of Sydney recently identified a disease that is killing Australian koala bears as Cryptococcosis (see *New Scientist*, Vol. 14, p. 461). Further work has now shown the probable way in which the animals contract the disease.

During autopsies on several bears, quantities of porous gravel were found in the caecum (the blind gut). Geologists at the university think it likely that this gravel originates in surface soils. If they are right, it confirms the observation that koalas sometimes descend from trees to eat soil, presumably in order to correct a mineral deficiency. Unfortunately the soil probably also contains the fungus responsible for cryptococcosis. (A. Bolliger, *Australian Journal of Science*, Vol. 24, p. 416.)

Men spin for two weeks

SCIENTISTS HAVE predicted that men will feel more at home in space stations if these rotate. It is possible, however, that any advantage from such artificial "gravity" will be cancelled by feelings of dizziness. To find out how well human beings can adapt to prolonged rotation and close quarters, four men recently spent a fortnight in a revolving compartment at the US Navy's School of Aviation Medicine at Pensacola, Florida. For eight hours every day they were given performance tests and doctors examined their balance, reflexes, memory and alertness.

The results showed that the men experienced dizziness only for a few hours at the beginning and end of their long spin. Their physical and mental capabilities were not lessened—in fact the doctors noticed a slight improvement. Further experiments are planned. (*Naval Research Reviews*, No. 4 62, p. 26.)

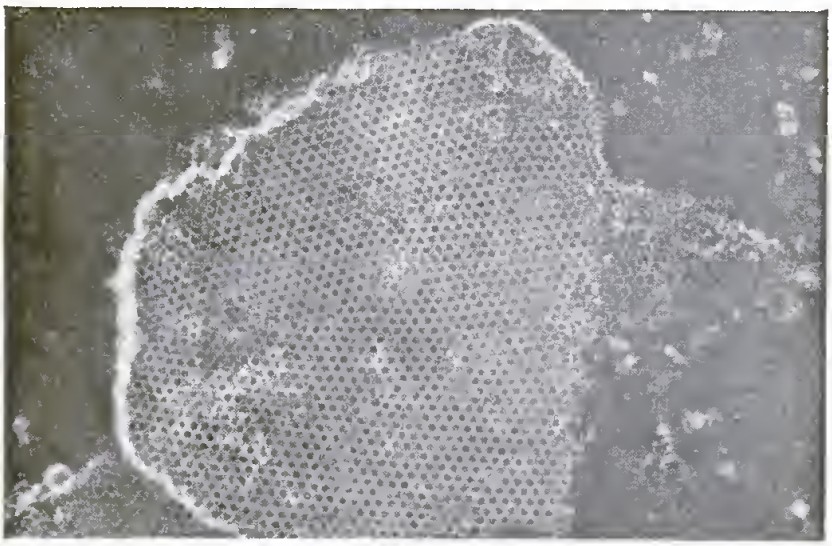
Chilean forest thrives on fog

THE FOREST OF Fray-Jorge in Chile, situated at a latitude of 30° S, lies at an altitude of some 1,500 feet and is about three miles inland. In appearance and plant composition it is a typical rain forest. Yet meteorologists claim that its rainfall is not more than six inches a year—nearly all, moreover, occurring between May and August—corresponding to a very arid climate.

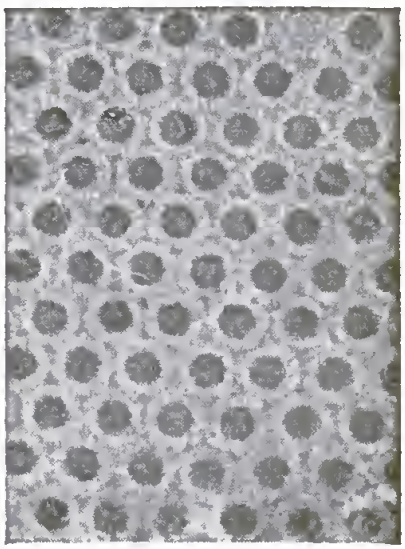
To find out whether the necessary humidity comes from another source, J. Kummerow, of Santiaga de Chile, has measured the contribution from fog which is frequent in the region. He placed a fog meter on open land in front of the forest, a pluviometer underneath a big tree and another control pluviometer also on the open land. The results were striking. Between October and December he found a weekly rainfall average of less than ¼ inch with none in November and December. Average fog precipitation, however, in the fog meter was nearly 1½ inches a week and condensed fog under the tree averaged about 2 inches a week over the periods of observation. (*Naturwissenschaften*, No. 9/62, p. 203.)

Trends and Discoveries *continued*

The basic structure of a virus coat and some cell membranes?



Saponin treated chick liver cell membrane. 120,000×.



The same. 640,000×.

RECENT ELECTRON microscopic studies of the Rous sarcoma virus, which causes tumours in chickens, have revealed new information about the structure of its outside envelope. What is important, however, is that the same kind of structure may be present in the membranes of several different types of cell. The work was carried out at the Mill Hill laboratories of the Imperial Cancer Research Fund by R. R. Dourmashkin, R. M. Dougherty and R. J. C. Harris (*Nature*, Vol. 194, p. 1116).

Fifty years ago, Peytoo Rous found that saponin inactivated the Rous sarcoma virus. The Mill Hill biologists repeated Rous's experiment on purified virus preparations; they then examined the virus particles in the electron microscope by the method known as negative staining. This showed that saponin treatment produced a hexagonal array of pits on the surface of the virus membrane. The pits were remarkably constant in diameter and spacing—about 80 Å across, with a centre-to-centre distance of some 150 Å. Treatment of membranes from the connective tissue cells of chicks infected with the virus revealed a similar structure. Moreover, membranes from quite different cell types reacted in the same way—for example, chick liver cells (illustrated) or human red blood cells.

The Mill Hill workers conclude that the Rous virus' external membrane was derived from the cytoplasmic membrane of the cell which it had infected—as, indeed, has been assumed in the past. It is possible that the hexagonal array of rings illustrated represents a basic structure for the cell membrane and the outside coat of the virus. A. K. Parpart and R. Ballentine have previously suggested that cell membranes are made up of hexagonally arranged cylinders of lipids (fats) surrounded by protein; J. F. Danielli and H. Davson, however, proposed a structure made up of bimolecular leaflets of lipid sandwiched by protein. The former theory has been favoured as an explanation of the permeability of the cell membrane—an important factor in cytological processes.

Saponin is a mixture of compounds that can be extracted from several plants, including a relative of the foxglove. *Digitalis lanata*. They are characterized by their ability to dissolve red blood cells, and have been used by Indians in South America to kill fish. A pure, commercially available member of the group is digitonin which combines with the cholesterol in animal fats, to form an insoluble complex. Treatment of cells or virus particles with digitonin, however, did not produce pits in their surface membranes. Instead, the membranes appeared stiffened under the electron microscope. The research team found also that saponin had no pit-forming effect on digitonin-treated cell membranes. This suggested that the availability of cholesterol was necessary for the effect, and it is possible that the pits exposed by saponin originally contained fats.

If the Mill Hill researchers can prove that the common basic cell membrane structure is in fact a meshwork of protein interdigitated by lipids, it will be interesting to speculate on the geometric arrangement of the units of such a system. The technique suggests several promising lines of study: on specialized membranes such as nerve axon sheaths; on the relationship of membrane-attached antigens to this structure; and on other viruses that may derive their membranes from the infected cell membrane.

Falling spheres to measure high winds

A NUMBER OF methods have been used to determine the changes in wind velocity and density in the region of the Earth's atmosphere called the mesosphere—the zone extending from about 80,000 feet up to 300,000 feet. Such measurements are important, of course, in connection with the performance of rockets at these heights. Meteorological balloons carrying radio sondes can reach 120,000 feet, but above, rocket techniques must be used. Early methods, still largely in use, rely on the radar tracking of strips of metal foil ("window") ejected from rockets, or the optical tracking of luminous clouds from rocket-borne grenades. It is also possible to obtain information from Doppler shifts in radio waves reflected from ionized meteor trails.

Last December, however, the Weapons Research Establishment, Salisbury, South Australia, experimented with a new technique that involved following the trajectory of a falling inflated sphere that had been carried up to some 400,000 feet by a two-stage sounding rocket. In a recent issue of *Nature* (Vol. 194, p. 1231), B. Rofe, who was responsible for the experiment, describes its results. The sphere was made of metal-coated plastic, 0.0005 in. thick, and was inflated by isopentane gas to two metres diameter. Its descent was tracked both by radar and by optical methods and measurements of its rate of fall produced modifications to the known density profile (to within 5-10 per cent at heights of 240-300,000 ft), from which could be calculated new values for the temperature and pressure variations.

From the trajectory of the sphere, its trackers deduced further modifications to the wind profile between 220,000 and 80,000 feet. It seems likely from its successful outcome that the method might prove the most useful for an extended survey of these parameters of the atmosphere.

LETTERS

Vegans and vegetarians

Sir,—Your note (*Dangers of being a strict vegetarian*, 21 June) referring to the clinical survey on twelve vegans (vegetarians consuming no animal food) by Dr A. D. M. Smith (*British Medical Journal*, 16 June, p. 1655) greatly interests us as we are carrying out a similar investigation on vegans which is confirming Dr Smith's findings and also those previously reported on nineteen vegans by Wokes, Badenoch and Sinclair (*American Journal of Clinical Nutrition*, 1955, *3*, 375). We find in vegans serum B_{12} levels of the same order as those recorded on vegans in the above two investigations (averages 128 ± 15 and 116 $\mu\mu$g/ml respectively) and much lower than the average levels in vegetarians (330 ± 27) and meateaters (about 360) reported in Hamburg last year by Wokes and Smith to the Second European Symposium on vitamin B_{12}. We also agree with Dr Smith who, when describing his findings to a meeting of medical colleagues and vegan volunteers in Dr Alan Stoddard's rooms last year, had no fault to find with the health of the vegetarians with their high serum B_{12} levels.

The critical serum B_{12} level seems to be about 200 $\mu\mu$g/ml below which peripheral neuritis, amenorrhoea and other signs and symptoms may begin to appear. Statistical examination of the data showed that this low level, present in about two-thirds of the vegans and about 1 per cent of the meateaters, would not be expected to be reached by more than a tiny fraction of the vegetarians in this country. Their high serum B_{12} levels are due mainly to the eggs, milk and cheese in their diet providing similar amounts of B_{12} to those in meat which (apart from offals) is not a very rich source of the vitamin (McCance and Widdowson, *The Composition of Food*, 1960). Some B_{12} in the vegetarians' blood may have come from certain new vegan foods (e.g., Barmene, Velactin) now being fortified with the vitamin and providing sufficient of it to avoid any necessity for the liver injections suggested in your note.

This note also mentions atrophy of the mucous membrane of the stomach as occurring in vegans. Our findings do not confirm this. Dr Smith detected no abnormality in a gastric biopsy on a vegan whose serum B_{12} level had been below 100 $\mu\mu$g/ml for at least six years. Since vegans have no lack of intrinsic factor their supplements of vitamin B_{12} need not be injected, as your note suggests, but can just as well be given by mouth, preferably in suitable foods fortified with the vitamin. Some years' experience in the fortification of vegan and vegetarian foods with vitamin B_{12} indicates this to be efficient and inexpensive.

Some vegans appear to remain in perfect health in spite of low serum vitamin B_{12} levels. In other cases the serum B_{12} levels remain above the probable critical level of 200$\mu\mu$g/ml, possibly due to absorption of vitamin B_{12} manufactured by the gut bacteria. However, no proof of this is so far available. We have a vegan whose serum B_{12} has remained at about 30 $\mu\mu$g/ml for many years and yet is in good health. Clearly the whole question needs extensive investigation and any dogmatism at this stage is unwarranted.

Anatomical and physiological evidence does not support the suggestion that man is primarily a carnivore. In carnivorous animals the concentration of gastric hydrochloric acid is considerably higher than in man, and the gut is much shorter. Normal levels of gastric hydrochloric acid have been found in vegan teenagers who have had no animal food since weaning.

The fact that vitamin B_{12} occurs in animal but not in plant protein is particularly significant in relation to protein malnutrition prevalent in the bulk of the world's population living on diets very low in animal protein and containing insufficient plant protein. From our study of one major area (India) presented to the Nutrition Society in London last year we believe the main solution to the problem to be an increase in the supply of plant protein which requires much less land for its production. The biological value of this plant protein may have to be improved by addition of vitamin B_{12} (low serum B_{12} levels in Indians indicate a deficiency of this vitamin).

Considerable difficulties will have to be overcome in implementing this programme, and we hope that our investigations on vegans and vegetarians in this country may prove helpful in this direction.

FRANK WOKES.

Vegetarian Nutritional Research Centre,
Garston,
Watford, Herts.

F. R. ELLIS.

Kingston Hospital Pathological
Laboratory,
37 Coombe Road,
Kingston-on-Thames.

Freedom from hunger

Sir,—May we congratulate the *New Scientist* on being one of the very few journals to give publicity to the launching of the Freedom from Hunger Campaign in Britain.

Professor Ritchie Calder mentions several projects associated with the Campaign in Africa. May we call attention to one in India, which while falling within the context of the large-scale United Nations plan, and involving an expenditure of £180,000, can nevertheless be broken up in such a way that the small group, the school, or the church, with a target of one or two hundred pounds only, can take a continuing interest in one community and know that in terms of human welfare their comparatively small contribution counts.

As its first pilot project War on Want is sponsoring the development of a destitute area in Assam, India, containing 40 villages. The landlords of this area have responded to the call of Vinoba Bhave, beloved disciple of Gandhi, to relinquish their rights: land is pooled and village democracy established. One village; one family. To make each village self-supporting approximately £450 is needed. This sum can be reached by stages: £150 for village well, or for better animals; £38 for agricultural equipment, village industries, credit fund or maintenance of village worker. In partnership with the Bhoodan Movement it is possible to contact the village committee, supply wells, bullocks, farm implements and educational equipment—watch the village grow. War on Want hopes to sponsor the development of ten such areas.

The Bhoodan Movement is the first case in history of the voluntary distribution of land unaided by the capital usually needed for compensation. As such it might well guide the agrarian policies of Asian nations, and kick off a social and economic revolution extending far beyond the coastline of India.

OLWEN BATTERSBY,
Research and Field Worker.

War on Want,
9 Madeley Road,
London, W5.

Aircraft shadow and bright spot

Sir,—D. Harrison and N. Hodson (*Letters*, 21 June) say that "the controversy of aircraft shadow and bright spot formation . . . revolves around the question of reflection from multiple parallel flat surfaces". It does not. When, in despair of putting across a verbal explanation, I present drawings (*Letters*, 17 May), they are apparently misunderstood to mean that the leaves are all parallel to the surface of the paper on which they are drawn. My explanation of the bright spot has *absolutely nothing whatever* to do with reflections of the Sun from leaf surfaces. It is, simply, that the observer in the aeroplane sees only sunlit leaves in the bright spot, and a mixture of sunlit and shadowed leaves in all other directions. The leaves can be of any shape at any orientation, and if I had drawn pine "needles" instead of deciduous leaves, they would have shown the same phenomenon.

If Mr Harrison and Mr Hodson will look up from the *Letters* section of the *New Scientist* and glance out of the window at real leaves, they will observe that:

(*a*) They can actually *see* leaves in all directions. Yet they profess to believe Dr T. R. Kaiser's hypothesis that the light entering the leaves "will not re-emerge, except for the part which is scattered back along the path of the incident light". If all the light emerging from the leaves goes back towards the Sun, how can there be any left over to reach their eyes and enable them to see the leaves?

(*b*) No two leaf surfaces are parallel, and not only do they all lie at different orientations, but the slightest breath of wind causes the orientation to change. Yet if leaves are to reflect the Sun from the bright spot and nowhere else, every portion of every leaf in the entire landscape would have to lie in a plane exactly at right angles to the Sun's direction, to the nearest fraction of a degree, and to maintain this precise orientation however hard the wind blows

To test whether leaves reflect the Sun's image at all, I have just been holding some grass blades and deciduous leaves in the sunligbt, keeping them flat, holding them up in various directions in relation to the Sun, and turning them till they take up the angle at which a mirror would give a reflection of the Sun's image. They do not give a reflection of the Sun's image, but they do shine brightly over an area whose diameter subtends an angle of 5° at the observer's eye (the Sun's image would be only half a degree in diameter). This bright reflection can be obtained from either side of the leaf, and it is extremely bright if one holds the leaf within 40° of the direction of the Sun (not 180°, which is the position of the bright spot). It follows that these reflections could reach the observer from *any* direction where there is foliage, but the reflections would only come from those particular leaves which were orientated within 2½° of tbe angle at which a mirror would reflect the Sun's image. If the leaf orientations were randomly distributed, these reflections, according to my calculation, would reach the observer from only about one leaf in every 1,000. This proportion would be the same in the bright spot as anywhere else.

A. E. SLATER.

Dell Farm,
Whipsnade, Bedfordshire.

Eye fatigue and fluorescent white paper

Sir,—Mr J. A. Pbillips's query about the effect on eyesight of fluorescent compounds in writing paper cannot bc answered without also referring to the materials surrounding his writing point. This is because the sensation of whiteness (and, indeed, of brightness) is relative; wben Mr Phillips says that his fluorescent paper appears "whiter than a pure white surface", he is making an incomplete statement. Thus, a perfectly black paper (not in fact obtainable) would reflect no ligbt whatsoever; but an ordinary commercial "black" paper can be made to appear whiter than any given commercial "white" paper—even a fluorescent one—simply by directing sufficient white tight on to it.

In the United States, very much greater levels of artificial illumination are common in working interiors than are used in this country, with no ill effects. This is because the amount of *contrast* between workpiece and surroundings is kept small. If a work surface (or a television screen, for that matter) is illuminated to a much greater level than its background, then a sense of strain will develop in the viewer; which is why one should not view television in the dark.

This means, of course, that Mr Phillips is right about tinted paper giving less strain in a given situation than fluorescent paper—it reflects less light, therefore reducing contrast. But he could just as well try covering his desk with something that reflects more light: i.e., something brighter.

C. FLEETWOOD-WALKER,
Senior Lecturer-in-charge.
Interior Design Section,
Birmingham College of Art.

Life on other worlds?

Sir,—It seems to me that the most probable explanation of "organized elements" in carbon-bearing meteorites dealt with in Dr Gaskell's article *Do Meteorites Reveal Life on Other Worlds?* (31 May) was not mentioned.

If one makes the assumption that an eruption of the Earth's surface could have been sufficiently violent to have placed into orbit about the Earth masses of surface material, the origin of meteorites is not limited to being extra-terrestrial and we may find ourselves potholing with meteorite nets instead of pick and shovel.

In response to natural laws and irregularities thereof, meteorites of earth-volcanic origin may well be circulated in orbits of such perigee that "fallout" or re-entry into the atmosphere would be on a grand time scale and appear to be of random occurrence. It is reasonable, I believe, to conclude that some "terrestrial meteorites" are presently in orbit and have fallen back to Earth bearing with them specimens of prehistoric "organized elements".

By way of a modern counterpart of this concept in partial action, I point to the eruption of Krakatoa in 1883 during which it was reported that stones were projected into the atmosphere "17 miles or more". Apparently sufficient initial velocity was imparted to tbe stones to carry them through the resistive atmosphere and into the vicinity of the manned balloon altitude record. As has been pointed out by von Pirquet, Obertb and Valier, a 3,000 foot cannon with its muzzle at 20,000 feet could possibly accomplish Jules Verne's "Moon shoot". A four-mile-high explosive volcano would certainly compare well with such ordnance.

ROBERT E. LUCAS.

The University of Arizona,
Tucson, USA.

The chess playing "robot"

Sir, With regard to the letter of C. S. Ogilvy (28 June) those interested may also read pages 55-57 of *History of Conjuring and Magic* by Henry Ridgeley Evans, published in 1928 by the International Brotherhood of Magicians at Kenton, Ohio. Included are eleven diagrams, obviously taken from some detailed description of the device, and there are references to three other writers who explained the *modus operandi*, apart from Edgar Allen Poe.

The concealed assistant in Maelzel's time was a broken-down chess expert named Schlumberger. The automaton was destroyed in a fire in 1854.

W. E. SUTTON.

23 Bromley Avenue,
Bromley, Kent.

Safe use of new drugs

Sir,—While still contemplating the appalling misfortune resulting from the effects of thalidomide on unborn children, I read in your issue of 28 June on page 703 (*Malaria eradication in Africa*) that "an alternative method [of eradication] is the addition of an antimalariat drug (chloroquine) to common salt that is used regularly by the whole population. This method, introduced ten years ago by Pinotti in Brazil, is now undergoing field trials in Ghana and Tanganyika". On page 719 (*Trends and Discoveries*) of the very same issue we read: "Certain drugs, in particular chloroquine, an antimalarial and antiarthritic agent, have a toxic effect on the retina, which is not always apparent until the damage is done."

Malaria is a deadly disease, and yet, at least from an armchair, it seems a highly questionable procedure to place in jeopardy the sight of thousands, maybe millions, of people without their full knowledge of what may be involved.

Has not the time come to reconsider the whole problem of mass medication and its implications?

F. ROSENSTIEL.

5a Mercier Road,
London, SW15.

Straightening up in orbit

Sir,—On 24 May you published a letter frnm Mr Bardwell-Jnnes in which he described a device which appears to disobey the law of conservation of angular momentum. No one has yet replied to that letter. May I point out the fallacy?

Gyroscopic precession occurs when a rotating body is subjected to a force-couple in a directinn perpendicular to its rotation. During the precession of Mr Bardwell-Jones's flywheels this couple will react thrnugh the gimbals on to the beam, slowing dnwn its rotation. The device will reach equilibrium when the beam has stopped rotating, and the flywheels will then be rotating in npposite directions about axes which are parallel to one another. The direction of these axes relative to that about which the beam is suspended depends on the disturbance which initially upset the unstable equilibrium of the system.

The total angular momentum of the system, throughout its motion, is zero, and thus, as with all macroscopic closed systems, the law of conservatinn of angular momentum is obeyed.

D. O. WILLIAMS.

111 Harborne Road,
Edgbaston, Birmingham, 15.

Books

Scientific uses of shock waves

by Dr B. P. Levitt

Shock Waves in Chemistry and Physics. By John N. Bradley.

Methuen, xiv+370 pp., 63s.

SHOCK waves are generated whenever a gas is pushed faster than the speed of sound. Their destructive effects are familiar as the blast produced by the sudden expansion of an explosive or as the sonic boom from the passage of a wing through the air in supersonic flight. At the higher speeds encountered by missiles (and returning astronauts) a second effect becomes important: the generation of heat. How much is felt by the projectile depends on the temperature behind the shock and so on the extent of ionization and chemical reaction produced in the atmosphere.

It is just this facility of sudden temperature rise that makes the shock tube so useful in the laboratory. Many fast reactions occurring in space technology or combustion cannot be studied in these systems directly because they are either complex or inaccessible. But normal laboratory techniques of heating are too slow: the reactions are over long before the gas is fully heated. When a shock wave passes through a gas the energy of motion is converted into heat within a few tens of molecular collisions. This is faster than any chemical reaction, and faster too than the kinetic energy of the molecules can flow into their internal modes of bending and stretching. The shock tube can be used to study not only chemical reactions, but also rotational and vibrational relaxation and any other molecular process which can be observed in about a thousandth of a second. The very high temperatures (over 10,000°C) needed to ionize the gas can be reached without difficulty.

The variety of chemical and physical problems investigated by shock waves is reflected in the diversity of scientific journals in which the results are published. Some of the work in the United States has appeared only in reports which are not readily accessible. Dr Bradley's account will therefore be welcomed for its comprehensive coverage of a rapidly growing field. The first half of the book deals with theory and techniques; the second is an account of molecular processes at high temperatures emphasizing results obtained using shock waves.

The book begins with a short description of the formation of shocks and the nature of the transition. The necessary hydrodynamic theory is clearly developed, and then applied to give the working equations needed, for example, to calculate the temperature rise from the velocity of the wave. A particularly valuable feature of this section is the discussion of deviations from simple one-dimensional theory found in practice, since these often set a limit to the temperature which can be reached.

The chapter on experimental techniques discusses the design and operation of a variety of shock tubes: all are basically composed of two lengths of straight pipe separated by a thin diaphragm. The pressure in one section is increased until the diaphragm breaks: the expanding gas acts as a piston sending a shock wave into the low pressure section. The instruments used to measure the velocity of the shock and to follow changes in the hot gas are critically examined. Since these must have a rapid response, optical methods are widely used.

The second half opens with an account of relaxation processes. Whilst ultrasonics can provide more accurate results, measurements of vibrational relaxation times in the shock tube cover a wider temperature range: the agreement between the two methods is impressive. Rotational relaxation is observed in the shock tube as a thickening of the shock front, and its measurement is bound up with shock front structure studies. Again the results complement those from ultrasonics.

The chapter on ionization outlines the information which has been obtained about the kinetics of ion production and plasma formation. Emission of light from electronically excited molecules is described separately. This sort of experiment should help determine whether the production of these highly endothermic species depends on the total thermal energy or only on the translational temperature of the gas.

Consideration of chemical reactions begins with the dissociation of diatomic molecules, including a particularly clear account of the relation of shock tube dissociation rates for the halogens to recombination rates obtained by flash photolysis at room temperature. The decomposition of the nitrogen oxides is described in detail. A short, but important section on the hydrogen-oxygen reaction is followed by results for the pyrolysis and oxidation of hydrocarbons.

This book will be a valuable addition to any physical or chemical library; while it will become an indispensible reference book for those using shock techniques, it is also of interest to all concerned with molecular processes at high temperatures. The author and publishers are to be congratulated on both the complete indices and extensive bibliography provided and the elegant typography and layout of the book, which make it a pleasure to read.

CD in the USSR

Civil Defense in the Soviet Union. By Leon Gouré.

California U.P./Cambridge U.P., 207 pp., paper 20s., cloth 40s.

LEON GOURÉ is a member of the Rand Corporation and this publication has the Rand stamp on it. Words such as "posture" and "capability" are overworked as usual, but in general the book is easy to read and free from jargon. The information has been hard to collect, but it is extremely well documented with nearly 20 pages of references to sources.

Civil Defense in the Soviet Union is a valuable contribution to the literature on the present nuclear situation. Civil defence is an extremely interesting aspect of this problem since any civil defence programme which is remotely commensurate with the actual threat that nowadays hangs over civilian populations—particularly those of the nuclear powers—must bring home to the man in the street the full magnitude of his danger. This clearly has important political, as well as strategic, implications. Also, it has long been the Rand thesis that the possession of an optimum civil defence system would greatly increase the flexibility of a country's nuclear strategy and diplomacy.

In Britain the essential information on nuclear weapons is available in two excellent Civil Defence Manuals* to be had by anyone from HM Stationery Office for the modest sum of 3s. 9d., but these do not reach the general public. The semi-official "one-in-five" courses are naïve and give only part of the truth. The lecturers are specifically instructed not to answer questions on, for example, the relation of fall-out areas to bomb sizes, which would reveal the full extent of the peril. To a good first approximation, we have no civil defence in Britain and the population as a whole remains defenceless but reasonably complacent.

Mr Gouré shows that civil defence training in the USSR is much more extensive than in Britain. On paper, at least, practically the whole population has had some instruction. But until 1953 nuclear weapons were not mentioned. In 1958, a 14 hour CD course for the "entire adult population" dealt with kiloton weapons (Hiroshima type) in some detail, but H-bombs were almost ignored and distances of down wind fall-out intensities were described as "tens of kilometres" in cases where they are actually several hundred miles. Since 1960 it would appear that the situation has been more realistically presented to the public on a compulsory mass basis, but genetic and other long term effects of nuclear explosions are still not discussed.

The actual physical measures taken are sufficient to show that civil defence in the Soviet Union is "an integral part of the country's defense posture" and is not a propaganda move to reassure a worried population. However the present plans are only designed to deal with a limited attack for which there is ample warning (several

days). It would appear that civil defence is more realistic than in Britain and is being steadily developed, but there is no direct evidence that the USSR will shortly have a full scale shelter system which will substantially increase what I suppose Herman Kahn and Stephen Potter in a double act would call her "nuclear brinkmanship capability".

P. T. MATTHEWS

* Manual of Civil Defence, Vol. 1, No. 1, *Nuclear Weapons*. HMSO (1959), 2s. 6d. Manual of Civil Defence, Vol. 1, No. 2, *Radioactive Fall-out*. HMSO (1956), 1s. 3d.

Life in the past

Instructions to Young Naturalists IV: Fossils. By W. E. Swinton.

Museum Press, 112 pp., 12s. 6d.

Animals Before Adam. By W. E. Swinton.

Phoenix House Ltd., 60 pp., 12s. 6d.

THE writing of a popular book for children on any branch of science presents obvious difficulties, and this is perhaps particularly so in the case of palaeontology. Dr Swinton is, however, the sort of person who might be expected to do it successfully since he combines a knowledge of both geology and biology with the ability to write simply and clearly.

The two books are very similar in scope. Both try to give a picture of life in the past from its first appearance in the Cambrian up to the present day. Invertebrates and plants are not neglected but the emphasis is placed deliberately on vertebrate animals. In the Young Naturalist's volume an attempt is made to give a more balanced account of invertebrate life in the past, but in effect this deals only with the early period before the vertebrates made their appearance.

In both books the emergence of the vertebrates from water to land is adequately dealt with, but the author is perhaps at his best in reconstructing the appearance of the great mesozoic reptiles —Dinosaurs, Ichthyosaurs, Plesiosaurs, Pterodactyls, etc.—and also gives intriguing discussions on their mode of life and relationships to one another.

Animals Before Adam is of a more general nature and is well illustrated by photographs of actual fossils and by a number of fine reconstructions of fossil animals.

The *Instructions to Young Naturalists* volume is more particular and is intended to inspire, inform and to guide young people who are interested in fossils. It is well illustrated by excellent photographs of fossils, and also has many good line drawings. A useful reading list and a list of all the museums in Britain which have fossil collections are included in this volume, as well as field instructions on how to collect.

Both books are well turned out, with indexes, and although there is a certain number of errors one feels that they should fulfil their object of inspiring and stimulating the interest of senior school children in this fascinating subject palaeontology.

JAMES BROUGH

Science for industrial technicians

General Industrial Science. By Ernest H. Wise.

Blackie and Son, 454 pp., 25s. (40s. board edition).

THE industrial technician needs to learn a little about a lot. He is, then, in danger of learning less and less about more and more until he knows nothing about everything. In this book the author has set about providing a course which avoids this extreme but also avoids the opposite extreme of too great concentration on too narrow a front. He has succeeded in this brave effort to a remarkable extent and has done it, too, with a sense of humour that makes it all the more interesting for his reader. The book is written primarily for students preparing, in part-time courses, for the City and Guilds examinations in Chemical Plant Operation. For them it is an admirable book. But the layman, too, interested in a general way in how science is applied in the industrial world, will find it very interesting reading. Throughout, the text is liberally illustrated with good clear-cut diagrams and there is constant reference to the practical applications of the basic principles.

The work is divided into eight sections. The headings alone give an indication of the breadth covered - Industrial Chemistry; Heat, Light and Sound; Mechanics; Instrumentation; Electricity; Metallurgy and so on. Thrown in for good measure are some useful suggestions on how to tackle examination papers. All in the scope of some 400 pages; a formidable task.

A brief, clear treatment of chemical principles leads on to states and properties of matter, covering a wide range yet managing to compress much information into a small compass. A useful chapter on Quality and Testing contains sound comments on the problems and technique of sampling. So on to physics, divided mainly between heat and light. In the heat, fuels and heat utilization are naturally emphasized, while in light the usual elements are covered. Mechanics includes some fluids as well as consideration of forces and elementary strength of materials. To the industrial scientist instrumentation is of major importance, and it is a little surprising to find this dealt with very briefly. Yet what is there is good and very well illustrated. Technical electricity, another "must" for the technician, is well presented in essence, in a limited space. Much development has waited, ultimately, on the ability of the metallurgist to provide metals that will stand up to the conditions of use so that the section on metallurgy is very useful. The range of materials goes beyond the metals and a useful line diagram is given showing the major materials used in industry. A miscellaneous section includes a brief treatment of the basic principles of engineering drawing, dealing mainly with drawing board geometry.

The author has not followed the usual practice of providing exercises at the ends of the chapters and teachers in the subject will need to make this good themselves. There is a very useful bibliography, linked with the work of each chapter.

Overall, a good effort which meets with considerable success, with the emphasis on "why" rather than "how". Students will find it valuable, laymen interesting.

C. W. TONKIN

The criticism of Aristotle's system

The Physical World of Late Antiquity. By S. Sambursky.

Routledge, London, 1962. xii+189 pp., 21s.

PROFESSOR SAMBURSKY is already well known as the distinguished author of two books describing the scientific world picture of the Greeks (Pre-socratics, Aristotle, Atomists) and of the stoics. The present volume continues the account to the close of antiquity in the sixth century AD, largely through a selection and interpretation of texts from such writers as Alexander of Aphrodisias, Plotinus, John Philoponus, Hipparchus, Ptolemy, and others of the period. Such a study is welcome, if only in order to dispel the idea, still only too prevalent, that between the age of Aristotle and that of the 17th, not to mention the 13th or 14th centuries, there lay a time-interval in which any kind of scientific curiosity and inquiry was completely dormant; that Aristotle's ideas were handed on, uncriticized, from scholar to scholar, only to be abandoned suddenly at the dawn of our period when exposed to the blaze of experimental evidence. Sambursky's work proves that nothing could be farther from the truth. Certainly, experimental and applied science lagged; theoretical inquiry, however, continued to flourish, and "abstract" thinkers, like Democritus, Plato, Aristotle, Epicurus, and the Neo-Platonists were the really influential figures, rather than the great scientists of antiquity like Euclid, Archimedes or Apollonius.

The book traces the influence of Stoic and Neo-Platonic thought on the development of the criticism of Aristotle's system; the evolution both of continuum theory as well as atomic ideas in consequence, and above all the growing familiarity with the idea of the importance of the application of mathematics to physics. There are chapters on space and time, matter, mechanics, the concept of action, celestial physics. A special section is devoted to the sixth century John Philoponus, which manages in a particularly striking manner to bring out the ferment of thought to be found at the onset of the "Dark Ages", his astonishing anticipations of some modern dynamical conceptions, and his attempt to overcome the dichotomous Aristotelian conception of the universe in favour of a monistic scheme.

Not the least of the author's achievements is to bring the period to life by discussing it in modern and mature terms: in this way it will certainly help to stimulate the average physicist to enrich his general store-house of ideas.

G. BUCHDAHL

Books *continued*

Investigating behaviour

Conditioning and Learning. By E. R. Hilgard and D. G. Marquis. Revised by G. A. Kimble.

Methuen & Co., 590 pp., 60s.

THE original volume, which was published in 1940, has been considerably enlarged and radically revised. Much recent work is included and the book is, in this respect, very much up to date. Four virtually new chapters take the place of an equal number, on different topics, in the first edition. The remaining parts of the book have been extensively rewritten and sections drawn directly from the 1940 edition form only a small part of the whole. In spite of these modifications, the present book bears a strong family resemblance to its parent and this is a considerable achievement.

Taken as a whole, this seems to be one of the most successful recent publications of its kind within the field of animal psychology. It will be found valuable as a textbook and as a reference work. It therefore seems appropriate to assess it against a rather more strict critical standard than may usually be applied with profit to similar studies. The substance and worth of this edition lie, not between the covers of the book, but between the first and last chapters. The first chapter, which seems largely to be additional to the original work, is concerned with questions arising in the definition of learning. It is difficult to see that this chapter is other than clumsy, confused and misleading. For instance, a formal definition of learning is proposed in the following terms: "Learning is a relatively permanent change in behaviour potentiality which occurs as a result of reinforced practice." This statement taken as a definition seems ferociously to beg many of the questions with which the rest of the book is concerned. Further, the chapter seems to be entirely unnecessary, in that an understanding of the remainder of the book in no way depends upon it. It is to be feared that many students will succumb to discouragement at this stage.

The task of selection of topics and materials for discussion must, in this very extensive field, command sympathy. In general a good balance is maintained and much of the subject-matter of those chapters dropped from the previous edition is presented in other contexts and chapters. But a serious omission in this respect concerns studies of "problem-solving". The investigation of this aspect of animal behaviour has developed to a degree comparable to that of other topics which receive relatively extensive treatment; a case might be made here for a small increase in length, or for some economy in the first and last chapters. The final chapter is concerned with attempts to extrapolate the results of studies of learning in animals to the analysis of personality. This account seems rather self-defeating. For it is rightly emphasized that any exploration in this direction must be of the most tentative nature. The prudence engendered by this fact prohibits a theoretical discussion of any depth and the chapter is also less complete and thorough than those which precede it.

Finally, although the book is largely composed of accounts of recent experimental studies, a slightly quaint impression remains. It is difficult to give a precise reason for this. Perhaps it arises from the fact that the material is discussed, almost without exception, within the theoretical frameworks which were already established in outline when the first edition was published. Sophistications of these theoretical ideas are presented and examined, but there seems to be no real attempt to question the original principles at a basic level or to seek and assess alternative points of view. These early ideas may, of course, be essentially correct. But at this stage of development of the subject this hardly seems probable: and it is difficult to believe that *no* really novel theoretical ideas have been advanced during the past twenty years. However, the approach of the book is intended to be empirical rather than theoretical and these comments should not be taken seriously to detract from the extent to which an exceedingly difficult task has been accomplished.

A. J. WATSON

Mathematical reality

Mathematics and Industry. By John Crank.

O.U.P., 91 pp., 12s. 6d.

IF one offered Dip. Tech. students a textbook which sought to relate the industrial world with the theory on which they are working, they could retort that they have had at least a glimpse of their mathematics working and that such a book is merely an aid. Sixth form students are in a more difficult plight. For them the unreality of industrial mathematics is a very real problem.

Dr John Crank, head of the mathematics department at the Brunel College of Technology, attempts to help both categories of students and compared with current textbooks available, particularly for the sixth-former, *Mathematics and Industry* succeeds very well indeed. For example, one well-known textbook on differential equations fairly buzzes with "live" examples, radioactive decay, fermentation, electrical circuitry, right down to the plug-hole of the kitchen sink. But out of context as they are, such examples mean practically nothing to the sweating sixth-former.

This book supplies the missing context. Talking of spinning in the textile industry the author describes the process before casting the equations, with nuclear reactors he explains nuclear fission before calculating the travels of the neutrons. Linear programming, which probably means little more to the schoolmaster than it does to his charges, starts with a description of its commercial relevance and then goes on to its mathematical background. As for examples, finding the optimum diet from a list of foodstuffs ranging from cheddar cheese to gingerbread is likely to be a more exciting proposition than solving a selection of isolated equations using all the letters of the alphabet.

In fact Dr Crank has combined an industrial essay with a stimulating mathematical textbook. Every page relates theory to experience. From the infant school to the university more of this could revolutionize the teaching of mathematics.

JOHN DELIN

A study of twins

Twins in History and Science. By Luigi Gedda. Translated by Marco Milani-Comparett.

Charles C. Thomas, Springfield, Illinois/Blackwell Scientific Publications, 240 pp., £5.

IT has taken ten years for Professor Luigi Gedda's massive *Studio dei Gemelli* to be translated into English. The original Italian work contained nearly 1,400 pages and over 500 illustrations, many of them in colour, but this, the first of two volumes, consists of just over 200 pages of text, copiously illustrated, including eleven of the full-page colour photographs from the original. There has been a great deal of condensation, but the original was very diffuse so that the loss is minimal and the result mostly an improvement. The translation is a faithful one, but despite the lapse of ten years, the additions are extremely slight.

Beginning with twins in literature and mythology, the book describes in outline many of the novels which make use of the twin motif, and lists some historical references to twins. In the scientific section, the value of much of the comparative studies of frequency of twinning between countries is vitiated by failing to standardize the rates for distribution by age of mother. The variation in the frequency of fraternal twinning by maternal age is discussed in the following chapter among aetiological factors, together with parity, and heredity. Some of the pedigrees illustrated here show a remarkably high incidence of twinning, but cannot unequivocally support any simple theory of inheritance. A very full and well-illustrated account of the various forms of conjoined ("Siamese") twins appears in the chapter on embryology, and in the final chapter on anatomicial studies is assembled much of the evidence demonstrating the extraordinarily close physical resemblances between monovular twins.

Like the original, the book is encyclopaedic in its scope, but encyclopaedic also in its disjointedness and its lack of any clear purposive theme. Many readers will find it rather unselective and lacking in critical appraisal of the material presented. So little fresh material has been added that the book still dates to its original publication—for example, the human diploid chromosome number remains quoted as 48! Nevertheless much of the book will be of general interest, and its excellency of production reflects the standards we have come to expect of its publishers.

J. A. H. WATERHOUSE

CONTRIBUTORS

John Maddox (*Telstar and the future*) is Science Correspondent of the *Guardian*. Previously he lectured in theoretical physics at Manchester University. Mr Maddox is an Oxford graduate, married with two children.

(*pages* 130-132)

David Gordon Tucker (*Searching the sea with sound*) has been Professor and Head of the Department of Electrical Engineering at the University of Birmingham since 1955. Previously he spent five years with the Royal Naval Scientific Service and six years at the Post Office Research Station. Dr Tucker is a Member of the Institution of Electrical Engineers and a Member of the Council of the British Institution of Radio Engineers. He is also a Member of the Newcomen Society. He is married, has a daughter and three sons, and enjoys music and walking.

(*pages* 134-136)

Jack Leicester (*Automation in laundries*) has been Director of Research at the British Launderers' Research Association since 1956. For seven years up to 1941 he was engaged in the glass industry, and from 1941 to 1956 in the Chemical Department of HM Dockyard, Portsmouth. His special fields of interest now include automation, steam generation, heat-transfer and the purification of water and effluent. Mr Leicester is an Associate Member of the Institute of Chemical Engineers and a Fellow of the Royal Institute of Chemistry. He is 48, married with three children, an active Methodist, and interested in sailing.

(*pages* 139, 140)

Miles Weatherall (*A scientific approach to university teaching*) is Professor of Pharmacology in the University of London, at the London Hospital Medical College. Professor Weatherall was educated at Oxford University. His interests lie in the influence of drugs on ionic transport in tissues, and in the whole field of drugs and human behaviour; also in education in the widest sense. He is a member of the British Medical Association and the British Pharmacological Society, and is joint author of a book, *Statistics for medical students*. Professor Wetherall is 42, married with three daughters, and lives in Hampstead.

(*pages* 149-151)

Raymond Casey (*The changing map of Jurassic Britain*) is Principal Geologist at the Geological Survey and Museum. Previously he spent 23 years (except for war service) in the Palaeontological Department of the Geological Survey. His special study is the palaeontology of British Mesozoic deposits, particularly the mollusca. He is a Fellow of the Geological Society of London and a Member of the Council of the Palaeontological Society, and has published the first three parts of *A monograph of the Ammonoidea of the Lower Greensand*. Dr Casey is 44, married, with two teen-aged sons.

(*pages* 152-154)

Bryan P. Levitt (*Scientific uses of shock waves*) has been ICI Fellow in the Department of Physical Chemistry at Cambridge University for the past three years. In September he takes up a post as lecturer at Imperial College. Dr Levitt was educated at Rugby and at Corpus Christi College, Cambridge, then held a postdoctoral fellowship at Princeton University for two years. His field is the mechanism of gas-phase chemical reactions. He is a Fellow of the Chemical Society and a Member of the Faraday Society. His leisure interests include classical jazz and food and wine.

(*page* 162)

CLASSIFIED ADVERTISEMENTS

LINE RATE 8s. per line or space equivalent.
INCH RATE £4 16s. 0d. per single column.
HALF PAGE £72 10s.
PAGE RATE £145.

Advertisements received first post Monday will be published the following Thursday.

Advertisements should be addressed to:
The Classified Advertisement Manager
NEW SCIENTIST
Cromwell House, Fulwood Place
High Holborn, London, W.C.1
TEL.: HOLBORN 7554

BOX NUMBERS. A charge of 1s. per insertion is made for the use of a Box Number. Replies to Box Number advertisements should be addressed to: **Box No. —, NEW SCIENTIST, Cromwell House, Fulwood Place, High Holborn, London, W.C.1.**

OFFICIAL APPOINTMENTS

ROYAL MILITARY COLLEGE OF SCIENCE, SHRIVENHAM

Applications are invited for a SENIOR LECTURESHIP or a LECTURESHIP in ELECTRICAL ENGINEERING. Teaching is at University level. The successful candidate will LECTURE TO DEGREE COURSES AND SPECIALISED COURSES and assist with laboratory classes. There are extensive well-equipped laboratories. RESEARCH IS ENCOURAGED and work would be suitable for publication and submission for higher degree.

Qualifications: First or second class Honours degree or equivalent, together with, if possible, at least some experience of electrical engineering in teaching, industry, or in research establishments. Special experience in the field of electrical power and machines and/or electrical theory and measurements would be an advantage.

Salary range: Senior Lecturer—£1,396 to £1,720, Lecturer—£768 to £1,271. Starting pay may be above the minimum in both cases, credit for post-graduate experience and National Service. Superannuation under F.S.S.U. Prospects of permanency. Residential accommodation for single man, prospects of a house for a married man.

Further particulars and forms from the Registrar, Royal Military College of Science, Shrivenham, Swindon, Wiltshire.

BRITISH TECHNICAL ASSISTANCE
Farm Settlement Scheme for Eastern Nigeria

Two Soil Surveyors and an Analytical Chemist (Soils) to carry out a Soil Survey of the sites for development as Settlements and Institutes.

Candidates, under 45 with a good honours degree in an appropriate subject, must be experienced Soil Surveyors and Land Use Planners.

Appointments will be for one or two tours each of 15-18 months' duration with salary in range £1,100-£1,500 and a tax free overseas allowance of £1,485 (married) and £935 (single). Additional allowances payable in respect of dependent children. Free furnished accommodation. Free medical and dental treatment.

Apply, stating full name and giving brief particulars of qualifications and experience, to Director of Recruitment, Department of Technical Co-operation, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting RC./213/103/01.

FOURAH BAY COLLEGE
The University College of Sierra Leone

Applications are invited for Lectureship in Chemistry. Salary scale: £965 x £50-£1,415; £1,490 a £75-£1,790 p.a., entry point according to qualifications and experience. Negotiations in progress for salary revision. Outfit and family allowances (maximum £300). F.S.S.U. Passages on appointment, annual leave and normal termination. Part-furnished accommodation at reasonable rent. Detailed applications (6 copies) naming 3 referees by 31 August, 1962, to the Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1, from whom further particulars may be obtained.

UNIVERSITY OF GLASGOW
Assistantship in Zoology

Applications are invited for an Assistantship in Zoology. Salary scale: £900-£1,050 per annum. Initial salary according to experience and qualifications. F.S.S.U. and family allowance benefits.

Applications (3 copies) should be lodged, not later than 10th August, 1962, with the undersigned, from whom further particulars may be obtained.

ROBT. T. HUTCHESON,
Secretary of University Court.

VICTORIA UNIVERSITY OF WELLINGTON
New Zealand
Technician in Department of Zoology

Applications are invited from suitably qualified persons for the above-mentioned post. The technician will work under the direction of the Professor. In addition to general departmental duties he will be required to undertake the preparation of laboratory dissection, and other materials, the servicing of undergraduate laboratories, the care and maintenance of laboratory and field equipment, and to assist in field operations as required. A reasonable level of skill in the working of wood, metal and other material is desirable along with a knowledge of elementary chemistry adequate for the safe handling of chemicals.

The Department is active in routine marine as well as other researches and accordingly experience in the operation of launches, the construction and maintenance of nets, etc., will be a useful qualification.

The salary will be from £700 rising to £950 per annum; the initial salary according to qualifications and experience of the appointee.

Approved fares to Wellington will be allowed for the appointee, his wife and his dependent children. In addition, actual removal expenses will be allowed within specified limits.

Further particulars and information as to the method of application may be obtained from the Secretary, ASSOCIATION OF UNIVERSITIES of the BRITISH COMMONWEALTH (Branch Office), Marlborough House, Pall Mall, London, S.W.1.

Applications close in New Zealand and London on **10 August 1962.**

THE UNIVERSITY of MANCHESTER

Applications are invited for the post of LECTURER in the Department of METALLURGY of the Faculty of Science. Candidates should be graduates in Metallurgy preferably with some industrial or research experience in the field of engineering applications and/or properties of metals, alloys, their oxides or carbides. The successful candidate will be expected to undertake research into problems of materials and to assist in the teaching of metallurgical principles to Engineering and/or Dental Students. Salary on a scale from £1,150 to £1,950 per annum; initial salary according to qualifications and experience. Membership of the F.S.S.U. and Children's Allowance Scheme. Applications should be sent not later than July 31st, 1962, to the Registrar, the University, Manchester, 13, from whom further particulars and forms of application may be obtained.

THE UNIVERSITY of MANCHESTER

Applications are invited for the post of LECTURER or ASSISTANT LECTURER in MATHEMATICAL STATISTICS. Salary scales per annum: Lecturer, £1,150 to £1,950, initial salary according to qualifications and experience. Assistant Lecturer, £900 to £1,050 per annum. Membership of the F.S.S.U. and Children's Allowance Scheme. Duties to commence as soon as possible. Applications should be sent not later than August 4th, 1962, to the Registrar, The University, Manchester, 13, from whom further particulars and forms of application may be obtained.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY
Metallurgy Department

Mathematical Physicist required to work as Research Fellow or Lecturer on problems of Crystal Plasticity with established research group. Candidates already possessing doctorate preferred. Salary within lecturer range £1,150-£1,950, plus London Allowance, family allowances and F.S.S.U. benefits.

Applications to Professor J. G. Ball, Imperial College, London, S.W.7.

UNIVERSITY OF NEW ENGLAND
Australia
Demonstrator in the Department of Physiology

Applications are invited for the above post. Applicants with a degree in either Science, Agricultural Science or Veterinary Science will be considered for the position. Facilities will be provided for applicants who wish to study for a higher degree. The main research interests of the Department are: Climate Physiology and Acclimatisation; Physiological and Biochemical Individuality; Erythropoiesis and Anaemia; and Rumen Physiology.

Commencing weekly wage will be fixed according to qualifications and experience within Grade I: £A1,120 x £A60-£A1,360, Grade II: £A1,320 x £A80-£A1,560; or Grade III: £A1,560 x £A80-£A1,720. None of these figures includes the current cost of living adjustment of £A44 per annum. Tuition fees will be remitted for any course undertaken at the University by the appointee and allowances will be made for travel and removal to Armidale.

Applications, two copies, should be forwarded to reach the undersigned **by 10 August, 1962,** and should contain details of academic qualifications and experience, personal data, and the names of two people to whom reference may be made on their behalf, and a recent photograph. Applicants outside Australia and New Zealand should forward an additional copy to the Secretary of the ASSOCIATION OF UNIVERSITIES of the BRITISH COMMONWEALTH, Marlborough House, Pall Mall, London S.W.1, by the same date.

T. C. Lamble,
Registrar.

Armidale, N.S.W., Australia.

MINISTRY OF AVIATION requires CHEMISTS at Headquarters, London
(a) to initiate and progress research programmes to provide HYDRAULIC FLUIDS and AIRCRAFT LUBRICANTS of improved performance and to prepare and maintain specifications for these materials and
(b) for liaison work in the research and development field on FUELS and LUBRICANTS, with particular reference to the chemistry of the products, with the oil and aeronautical industries, preparation of specifications and development of test methods to secure optimum performance.

Appointments in the grade of Senior Scientific Officer (minimum age 28).

Qualifications: First or second class honours degree or equivalent, in chemistry and some years' post-graduate research experience in appropriate field.

Salary scale (Inner London rate). £1,462-£1,785 with Superannuation under F.S.S.U.

Forms from M.O.A. Est. 2/3 Room 516, Adelphi, John Adam Street, London, W.C.2, quoting HC/2D/0816.

UNIVERSITY OF ST. ANDREWS

Applications are invited for a LECTURESHIP in MATHEMATICS in Queen's College, Dundee, with effect from a date to be arranged. Salary scale: £1,150 x £50 to £1,500 x £75 to £1,950 (efficiency bar £1,500). Placing according to qualifications and experience. F.S.S.U., family allowance, grant towards furniture removal expenses. Applications (6 copies) containing the names of three referees, to be lodged not later than 11th August, 1962, with the Secretary of the University at Queen's College, Dundee, from whom further particulars may be obtained.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY

SENIOR TECHNICIAN required, with experience as Instrument Maker. Salary in scale £690 x £25-£815, plus £45 London Weighting and, if applicable, a Qualification Supplement of £30-£50. Superannuation benefits.

Applications, with full details of age, qualifications and experience and names of 2 referees to Prof. J. D. McGee, Physics Dept., Imperial College, London S.W.7.

NEW ZEALAND
Department of Scientific and Industrial Research

Applications are invited for the undermentioned vacancy:
VACANCY NO. 9/62/2096: SCIENTIFIC OFFICER, (ELECTRONICS ENGINEER), INSTITUTE OF NUCLEAR SCIENCES, LOWER HUTT

The Institute of Nuclear Sciences has a vacancy for an Electronics Engineer to supervise the maintenance and modifications to electronic equipment now in operation at the Institute, including four mass spectrometers and three low background shielded counter assemblies with associated electronics used for tritium and carbon-14 age determination measurements and to plan and design electronic equipment for experiments planned using the 3 Mec Van de Graaff accelerator to be installed at the Institute. The electronics group is expected to expand considerably within the next few years as plans are being formulated for the purchase and installation of a Research Reactor.

Qualifications desired: An honours degree in Physics, an Engineering degree in electricity or a similar qualification from a chartered professional institute with experience in the designing of transistorized pulse and digital circuits.

Salary: Up to £2,300 a year according to age and experience.

Passages:
From United Kingdom: Single persons—up to £172; married couple—up to £370; each child—proportion of £172.
From South Africa: £210 per person plus proportion for child.
From other countries: Minimum tourist class fare by the shortest route

Incidental expenses: Up to £35 for a single person and £100 for a married man can be claimed to cover the cost of taking personal effects to New Zealand.

Application forms and further details are available from the High Commissioner for New Zealand, 415 Strand, London, W.C.2, with whom applications will close on 5 September, 1962.

Please quote reference B.13/18/2 when enquiring

AIR MINISTRY
R.A.F. Institute of Aviation Medicine, Farnborough, Hants.
Senior Scientific Officer (Veterinary)

Post at FARNBOROUGH, Hants, for a man or woman to advise on and carry out ORIGINAL RESEARCH INTO THE EFFECTS ON ANIMALS OF ENVIRONMENTAL STRESSES ASSOCIATED WITH AVIATION, and to be responsible for selecting and maintaining a small colony of experimental animals of a wide range of species. The work forms an important part of the Institute's programme of medical and scientific investigation into problems affecting the efficiency and safety of flying personnel.

Qualifications: normally 1st or 2nd class honours degree in zoology or physiology, or M.R.C.V.S. or equivalent qualification. Experience of, or aptitude for, planning and conducting experiments in experimental physiology or allied sciences is desirable.

Salary scale: £1,396-£1,720, starting salary may be above the minimum. Promotion prospects and opportunity for permanent appointment if desired. Applications to above address.

THE UNIVERSITY of MANCHESTER

Applications are invited for the post of ASSISTANT LECTURER in the Department of METALLURGY of the Faculty of Science. Candidates should be graduates in Metallurgy or Chemistry, with practice or a direct interest in the application of thermodynamics and chemical kinetics to chemical reactions of metals, alloys, and their compounds. A vigorous research programme already exists in the vapour deposition of metals and the oxidation of metals and alloys. Duties to commence October 1st, 1962, or as soon as possible thereafter. Salary scale: £900 to £1,050 per annum, with membership of the F.S.S.U. and Children's Allowance Scheme. Applications should be sent not later than July 31st, 1962, to the Registrar, the University, Manchester 13, from whom further particulars and forms of application may be obtained.

UNIVERSITY COLLEGE OF SOUTH WALES AND MONMOUTHSHIRE

Applications are invited from honours graduates in Mathematics or Physics, or others holding an equivalent qualification, for a Research Studentship to perform theoretical work on semiconductors with a view to a higher degree. The appointment will be for a period of two or three years. Applications should reach the undersigned not later than Friday, 27th July, 1962.

E. R. Evans,
Registrar

Cathays Park,
Cardiff

D.S.I.R.

ROAD RESEARCH LABORATORY, SOILS SECTION, HARMONDSWORTH, MIDDX., requires **SENIOR SCIENTIFIC AND SCIENTIFIC OFFICERS** for the following:

1. Design and construction of earthworks for roads (practical experience of site work an advantage).
2. Research on stabilised soil and cement-bound base materials.
3. Full-scale and laboratory hydrological investigations in connection with road drainage problems. (Civil Engineer or Hydrologist.)
4. Work on problems relating to the structural design of roads, and full-scale and laboratory research in which experience in the field of soil mechanics would be an advantage.

Work frequently includes laboratory and field investigations and provides contacts with other scientists and engineers in this country and abroad. Extensive information and library service, design offices, workshops and other facilities exist.

Qualifications: 1st or 2nd Class Hons. degree in appropriate subject or equivalent. For S.S.O. some years' appropriate post-graduate research required.

Salary scales: S.O.: £805-£1,321—allowance is made in the calculation of starting salary for periods of post-graduate experience.

S.S.O.: £1,446-£1,780. Possibility of promotion to Principal Scientific Officer (Maximum salary £2,575).

The Laboratory is expected to move to Crowthorne, Berkshire, in about three years' time.

Application form from the Director, above address, quoting RRL35ZYW. Closing date 20th August 1962.

POST OFFICE
EXECUTIVE ENGINEERS

Pensionable posts in London and provinces for mechanical, electrical and electronic engineers (male) at least 21 and normally under 35 on 1.9.62, to develop and design communications systems and postal services. Candidates must normally have (or expect to obtain shortly) a degree, or Dip.Tech., in engineering or physics. Exceptionally, evidence of very high professional attainment may be accepted in lieu. Starting salary (Inner London) £762-£1,318 according to age. Scale maximum £1,573. Promotion prospects. Write Civil Service Commission, 17 North Audley Street, London, W.1, for application form, quoting S/322.

UNIVERSITY OF SINGAPORE

Applications are invited for (i) Lectureship or (ii) Assistant Lectureship in each of the following.
HISTORY OF SCIENCE
ZOOLOGY

Salary scales: (i) £1,148 x £49-£1,442/£1,540 x £56-£1,820 p.a. (ii) £1,001 x £49-£1,099 p.a. Entry point according to qualifications and experience. Allowances, expatriation in range £280-£308 p.a., cost of living (temporary) in range £210-£560 p.a. Passages for appointee, wife and children not exceeding 12 years. Partly furnished house/flat at reasonable rent. Provident Fund Scheme. Detailed applications (8 copies) naming 3 referees by 31 August 1962 to Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1, from whom further particulars may be obtained.

THE UNIVERSITY of MANCHESTER

Applications are invited for the post of LECTURER IN ARCHITECTURE from candidates with professional membership of the Royal Institute of British Architects and not less than three years of practical experience. The person appointed will have special responsibility for the development of lecture courses and instruction in management and buildings production, and will be expected to pursue original research in his subject. Salary on a scale £1,150 to £1,950, initial salary according to qualifications and experience. Membership of F.S.S.U. and Children's Allowance Scheme. Applications should be sent not later than August 20th, 1962, to the Registrar, the University, Manchester 13, from whom further particulars and forms of application may be obtained.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY
Thermionic Generation of Electricity

EXPERIMENTAL OFFICERS or SENIOR EXPERIMENTAL OFFICERS—metallurgists, physicists or physical chemists, preferably but not essentially with a degree—required for work on direct generation involving cathode preparation and testing to be sponsored by N.R.D.C. Salaries in range £850-£1,700, with superannuation benefits.

Applications to Professor J. G. Bell, Imperial College, London, S.W.7

UNIVERSITY OF READING
Department of Geology
Lecturer in Geochemistry and Metamorphic Petrology

Applications are invited for the post of Lecturer in Geochemistry and Metamorphic Petrology. Duties will include initiating and administering the geochemical and spectrographic units in the newly completed Sedimentology Research Laboratory. The appointment will date from September 30, 1962.

Further particulars may be obtained from the Registrar (Room 22, O.R.B.), The University, Reading, by whom applications (which should include the names of three referees) must be received not later than July 30, 1962.

APPOINTMENTS AND SITUATIONS VACANT

BICC

Have vacancies in their Shepherds Bush Research Laboratories for

LABORATORY ASSISTANTS

Boys or girls for a wide range of interesting duties in the fields of chemistry, physics, mathematics and mechanical and electrical engineering. Facilities are given for further education by part-time day release, and there are opportunities for sponsorship on to Sandwich Courses for the Diploma in Technology in the Sciences and Engineering after a period of satisfactory service with the Company.

The Laboratories are modern and well equipped and include excellent social facilities and staff restaurants.

The employment is progressive leading to a well paid appointment on the permanent and pensionable staff of the Company.

Applicants should have G.C.E. 'O' level in science subjects and have a desire to study for a higher qualification.

Applications should be made to

Personnel Officer,
BRITISH INSULATED CALLENDER'S CABLES LIMITED
38 Wood Lane, London, W.12.

UNIVERSITY OF READING
J. J. THOMSON PHYSICAL LABORATORY

Applications are invited for the post of RESEARCH PHYSICIST to carry out a programme of electron diffraction intensity measurements at high energies. This programme aims to provide some of the fundamental information needed for the improvement of the present-day electron microscope by extending existing data (which is mostly confined to energies less than 100 KeV) to 400 KeV and later to over 1 MeV. Applicants should have a higher degree in physics. Experience of high vacuum technique and/or electronic counting equipment is very desirable. The salary will be about £1,100 a year plus F.S.S.U. benefits. There may be an opportunity for the Research Physicist to undertake a small amount of teaching. Applications, including a statement of qualifications and experience, and the names of two persons to whom reference may be made, should be sent as soon as possible to the Registrar, The University, Reading.

TECHNICIAN (BIOCHEMIST) required for Hospital laboratory. Duties include analysis and apparatus maintenance. A.I.M.L.T. or equivalent qualification required. Salary on Whitley Council scale (P.T.B.). Applications to Professor of Chemical Pathology, Westminster Hospital Medical School, London, S.W.1

AUSTRALIA

COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANIZATION

DIVISION OF PROTEIN CHEMISTRY

POST-DOCTORAL FELLOWSHIPS

in

PROTEIN CHEMISTRY

The Organization's Division of Protein Chemistry located in Melbourne, Vic., invites applications from graduates in Chemistry or Physics for Post-Doctoral Fellowships. Applicants should have at least a Ph.D. degree or its equivalent, backed by research experience either in the protein field or with physical or chemical techniques which would find application in this field.

The Fellows selected will join a group of 25 research workers investigating various aspects of protein structure and chemistry. The protein research programme, which has been developed by this group over the past 12 years, provides an excellent opportunity for gaining experience in this field. A wide range of research equipment for chemical, physico-chemical, biophysical and histological studies on proteins is available and a choice of projects relating to both fibrous and globular protein will be offered for selection.

The Fellowships are offered for a period of three years.

SALARY: Commensurate with qualifications and experience: minimum offered £A1,750 p.a. up to a maximum of £A2,720 p.a.

Salary for women will be £A188 p.a. less than corresponding rate for men.

Fares paid for the appointee and his family and return fares to point of origin will be paid if the appointment is not extended at the end of the period. Further particulars of conditions, etc., supplied on application to:

Mr. P. F. Butler, Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, LONDON, W.C.2.

to whom applications (quoting Appointment No. 462/160) should be addressed by the **25th August, 1962.**

A PHYSICIST or MATHEMATICIAN required for optical design in the London area. Experience not essential and a recent graduate would be given training including attendance at daytime lecture courses. The work involves computational techniques including electronic computers. Box C786, New Scientist.

TEMPORARY JUNIOR SCIENTIFIC INDEXING ASSISTANT required. Some biological chemical knowledge desirable. Four months or longer. Salary £450 minimum. Apply Executive Editor, International Abstracts of Biological Sciences, 4 Fitzroy Square, W.1.

INSTITUTE OF CANCER RESEARCH: ROYAL CANCER HOSPITAL. TECHNICAL ASSISTANT required in Chester Beatty Research Institute, Fulham Road, S.W.3, to assist in biochemical investigations into nucleic acid metabolism in normal and cancerous liver. Candidates with G.C.E. A level in Chemistry and/or prev. lab. exp. preferred. Salary within range £400-£609 according to age, qual. & exp. Apply with names of 2 referees to the Secretary, 33 Sumner Place, S.W.7, quoting ref. 301/B/100.

A.M.I.Mech.E., A.M.Brit.I.R.E., City and Guilds, A.C.G.I., etc., bringing pay and security. "NO PASS NO FEE" terms. Over 90% successes. For details of Exams. and Courses in all branches of Engineering, Building, Electronics etc., write for 148-page Handbook—FREE. B.I.E.T. (Dept. 963), London, W.8.

TECHNICIAN required in CHEMISTRY Department; experience in teaching laboratories desirable. Salary in the range £490-£675 plus London Weighting and qualification allowance. Apply to the Secretary, Queen Elizabeth College (University of London), Campden Hill Road, W.8.

THE UNIVERSITY OF SHEFFIELD

Applications are invited from graduates in Physics wishing to undertake research in Solid State Physics or Radio Astronomy. Salary equivalent to D.S.I.R. research studentship. Apply to the Registrar, The University, Sheffield, 10.

LABORATORY ASSISTANTS

IN PAINTS DIVISION

Exams over? Ready to make a new start? Interested in Applied Chemistry? Looking for a career in the chemical industry?

We are recruiting Laboratory Assistants, mostly young men and women who are about to leave school with the basic qualification of G.C.E. 'O' level in 4 subjects including Chemistry and English.

We may be looking for you: you may be looking for us. If you think so, write and ask for an application form and the information booklet "An Inside View".

Our address is:

Personnel Officer (Technical Departments),
IMPERIAL CHEMICAL INDUSTRIES LIMITED,
Paints Division,
Wexham Road, Slough, Bucks.

METALLURGIST

Non-Ferrous Metal Manufacturers wish to appoint a graduate metallurgist to their Process Control Department. Industrial experience is not essential, providing the successful candidate possesses the personal qualities and ability to work as a member of an enthusiastic team. Pension scheme in operation. Apply giving full details of educational qualifications to

The Labour Officer,
THOMAS BOLTON & SONS LTD.
Mersey Copper Works, Widnes, Lancs.

STUDENT APPRENTICESHIPS
Johnson, Matthey & Co. Limited

refiners and high precision engineers specialising in the precious and allied non-ferrous metals, invite applications from boys leaving school this summer for

One apprenticeship in Mechanical Engineering
One apprenticeship in Production Engineering

Both will be of four years' duration, and will be on a sandwich course basis, with periods of six months' full-time studies at College, alternating with six months' practical training in the Company's factories. The courses will lead to Diplomas in Technology in Mechanical Engineering and Production Technology respectively.

Candidates must have a sound G.C.E. 'O' level in at least five subjects including English and Mathematics; they must have sat for their 'A' level in at least Physics and Mathematics, and final acceptance must depend on satisfactory passes in this examination.

Applications should be accompanied by full particulars of education, qualifications, age, interests, etc., and should be sent to the Company Education and Industrial Relations Manager, at 78 Hatton Garden, London, E.C.1, quoting reference C.1.

UNIVERSITY OF EDINBURGH
Department of Mathematical Physics—Lectureship

Applications are invited for the post of Lecturer in the above Department. The duties will include teaching of Mathematical Physics and Applied Mathematics at undergraduate level and assistance in the postgraduate and research activities of the Department, which are at present primarily concerned with the Quantum Theory of Fields and Nuclear Theory. Salary scale £1,150 x 50 to £1,350, Bar £1,400 x £50 to £1,500 x £75 to £1,950 per annum, with placement according to qualifications and experience, and with superannuation benefit and family allowance where applicable. The successful candidate will be expected to take up duty on 1st October, 1962.

Further particulars may be obtained from the undersigned, with whom applications, giving the names of two referees, should be lodged not later than 15th August, 1962.

CHARLES H. STEWART,
Secretary to the University.

July, 1962.

NATIONAL PHYSICAL LABORATORY

METALLURGISTS required as EXPERIMENTAL OFFICERS. ASSISTANT EXPERIMENTAL OFFICERS for:

(1) development of modern physico-chemical techniques of inorganic analysis. Experience of X-ray fluorescence analysis, gases in metals, or activation analysis particularly desirable.

(2) Ferrous metallurgy, including investigations into the causes of failure in steel components. Experience in metallography or X-ray crystallography is desirable.

(3) X-ray crystallography or general X-ray physics.

Qualifications: HNC or equivalent in appropriate subject (pass degree or equivalent if over 22). Age at least 26 for Experimental Officer.

Salary: Experimental Officer, £1,175-£1,439
Assistant Experimental Officer £501-£873 (age 26 or over)-£1,067

Application forms from Director, National Physical Laboratory, Teddington, Middx., quoting 73AB. Closing date 13th August, 1962.

FORENSIC SCIENTIST BIOLOGIST

at Home Office Laboratory, Birmingham. Pensionable post for man or woman normally under 29 on 31.12.62, as Scientific Officer for work in scientific investigation of crime, covering a wide field of scientific enquiry. The duties involve appearing in court as expert witness. Qualifications normally 1st or 2nd class hons. degree in Biology or equivalent. Salary scale £768-£1,271, starting salary may be above minimum. Write Civil Service Commission, 17 North Audley Street, London, W.1, for application form, quoting S.52/FSL. Early application advised.

TECHNICIAN, GRADE B, preferably with experience of general geological laboratory practice and training in rock sectioning, or TECHNICIAN, GRADE C, prepared to train further in general geological laboratory practice. Apply in own handwriting, stating previous experience, etc., to Professor F. W. Shotton, Geology Department, University, Birmingham 15.

ENGINEERING CADETSHIPS
in the
GOVERNMENT SERVICE

A number of Engineering Cadetships are being offered in various Government Departments to men and women under 26 on 31.12.62 (with extension up to 3 years for Forces service) who have (or expect to have within six months) a first or second class honours degree, or Diploma in Technology, in engineering or physics. Exceptionally, applicants who have served a student apprenticeship or similar course, and who are academically qualified for graduate membership of the professional engineering institutions will be considered. Selection will be by interview.

Successful candidates will be given a comprehensive course on engineering training lasting up to three years and designed to supply the basis of practical experience essential to a professional engineering career. Cadets who satisfactorily complete the course and obtain graduate membership of the appropriate professional institution will be appointed to the basic grade of professional engineer in the Civil Service. Promotion to the main grade of professional engineer may be expected after two to six years in the basic grade. Further promotion prospects are good. Employment will be in a pensionable capacity from the outset.

The salary (national scale) during training is £768 (1st year), £801 (2nd year), £833 (3rd year). Basic grade engineers receive from £892 (at age 24) to £1,308 (at 34) rising to £1,487, and main grade engineers £1,514 to £2,028.

For further particulars and an application form, write to Civil Service Commission, 17 North Audley Street, London, W.1, quoting S/565.

BORAX CONSOLIDATED LIMITED

Have vacancies at their Research Centre in Chessington, Surrey, for:

1. A chemist with a Ph.D. in physical chemistry or modern inorganic chemistry.
2. A chemist with a good honours degree in chemistry.
3. A chemist/chemical engineer with a degree or degree-standard diploma.

The programme of work at the well-equipped research centre covers a wide field of chemistry which is mainly of an inorganic or organometallic nature. The appointments to be made will be permanent and progressive and for the next few years the successful applicants will be required to engage largely in experimental work. Conditions of employment are above average, and benefits include non-contributory pension and life assurance schemes. Applications giving a brief outline of education and career to date should in the first instance be addressed to Staff Manager, Borax House, Carlisle Place, London, S.W.1.

THE UNIVERSITY OF SHEFFIELD
Department of Psychology

Applications are invited for the position of RESEARCH ASSISTANT to begin duties on 1st October, 1962. The position is financed by a D.S.I.R. research grant for studies on industrial training problems. The Department is particularly interested in automated methods of training. Salary in the range £600-£1,050 according to qualifications. Further particulars may be obtained from the Registrar, The University, Sheffield, 10, to whom applications (4 copies) should be sent by 1st August, 1962.

MEDICAL ELECTRONICS

Applications are invited for the post of ELECTRONICS TECHNICIAN in the Electronics Section of St. Thomas' Hospital Medical School. Qualifications: practical experience of the construction of prototype apparatus. O.N.C. or equivalent desirable. Work includes all types of medical instrumentation, other than X-ray and Isotope techniques. Salary in the range £719-£946 according to experience. Apply Miss Lincoln, St. Thomas' Hospital Medical School, London, S.E.1.

THE AGRICULTURAL RESEARCH COUNCIL require an Assistant Experimental Officer at their Pest Infestation Laboratory, to work on chemical problems in the fumigation of foodstuffs including development of analytical methods and the study of sorption. Minimum qualifications: G.C.E. in 5 subjects including two scientific subjects at Advanced level or equivalent; or, at age 22 pass degree or equivalent. Salary according to age in scale £458-£645 (at age 22)-£983 (under review). Contributory superannuation scheme. Apply to: Director, Pest Infestation Laboratory, London Road, Slough, Bucks.

SENIOR ASSISTANT ENGINEERS

required in the

Commercial Department

Central Electricity Generating Board

Headquarters, London, S.E.1.

Applications are invited for the above posts.

The duties will include assisting in the preparation of estimates of the costs of supply of Electricity and Steam, revenue and capital budgets, analysis of the cost of supply, and detailed work in connection with Bulk Supply Tariffs and tariffs for steam supplies; the preparation of estimates for short and long term trading forecasts, the purchase of electricity from outside bodies; investigation of the economic justification of schemes involving capital expenditure.

Candidates should have a good technical education and experience in the economic aspects of electricity supply. Preference will be given to those who are members of a senior Engineering Institution or possess an engineering degree.

● **Salaries will be within a scale £1,840-£2,145 or £1,955-£2,295 per annum according to qualifications and experience.**

Applications stating age, qualifications, experience, present position and salary, to the Appointments Officer, 24/30, Holborn, London, E.C.1, by 30th July, 1962. **Quote Ref. NS/384.**

THE UNIVERSITY of MANCHESTER

Applications are invited for the post of ASSISTANT LECTURER in ORGANIC CHEMISTRY. Salary on a scale £900-£1,050 per annum, with membership of the F.S.S.U. and Children's Allowance Scheme. Applications should be sent not later than August 1st, 1962, to the Registrar, the University, Manchester, 13, from whom further particulars and forms of application may be obtained.

BRITISH BAKING INDUSTRIES RESEARCH ASSOCIATION

Requires SCIENTIFIC ASSISTANT (£333-£780 p.a.) or ASSISTANT EXPERIMENTAL OFFICER (£458-£983 p.a.) to work in the physics laboratory. 5-day week. 3 weeks' annual leave, pleasant working conditions. Full details should be addressed to the Secretary, Baking Research Station, Chorleywood, Herts.

Standard Telephones and Cables Limited

QUARTZ CRYSTAL DIVISION

West Road, Harlow, Essex

Applications are invited from young graduates for the post of

EXPERIMENTAL PHYSICIST

to conduct experiments on the physical processes underlying the operation of quartz crystal vibrators. A good knowledge of classical physics is required and manual dexterity is necessary, as the experiments will involve some processing of crystal units.

This post is permanent and housing accommodation can be arranged for the successful applicant.

Applications, in writing, quoting reference 8231/AF8W should be made to the Personnel Manager at the above address.

Printed in Great Britain by GALE & POLDEN LTD., 28 Craven Street, London, W.C.2, at their Wellington Press, Aldershot, and published weekly by Harrison, Raison and Company, Ltd., Cromwell House, Fulwood Place, High Holborn, London, W.C.1. Telephone: Holborn 7554. Distributed by Vernon Holding & Partners, Ltd., 43 Shoe Lane, London, E.C.4. Telephone: Fleet Street 5591.

U.S.A. RESEARCH CENTRE

Applications are invited for posts on the staff of the Centre in the following fields:

MATHEMATICS

1. Information Theory.
2. Stochastic Processes.
3. Statistics.
4. Applied Mechanics.
5. Switching Theory.
6. Numerical Analysis.
7. Control Theory.

COMMUNICATIONS

1. Optimization of Information Gathering & Information Transfer Systems.
2. Human Factors.

Qualifications: Preferably Ph.D., with appropriate research experience, though consideration will be given to other levels of qualification if the combination of these and experience is adequate. Men finishing advanced degrees during the next 9 to 12 months are also invited to apply.

Applications: In confidence, with curriculum vitae, to:

O. Hall, M.A., B.Sc.,
2 & 4, TUDOR STREET,
LONDON, E.C.4.

who will give further information to bona fide applicants.

MACMILLAN & CO. LTD.

wish to make an immediate appointment of a Science Editor to assume responsibility for growing list of science books at all levels. Good science degree and publishing experience essential. Preferably under 40. Write giving fullest details to: Macmillan & Co. Ltd., St. Martin's St., London, W.C.2.

INSTITUTE OF CANCER RESEARCH: ROYAL CANCER HOSPITAL. ASSISTANT required in Physics Dept., situated in Royal Marsden Hospital, Fulham Rd., S.W.3 for work with radioactive isotopes and X-rays, involving development of new techniques for diagnosis and therapy. Applicants should possess G.C.E. A level in Physics or similar qual. Initial salary depending on age, qual. and exp. in range £370-£960. Applications with names of 2 referees to the Secretary, 33 Sumner Place, S.W.7, quoting ref: 301/B/101

MIDDLESEX COUNTY COUNCIL
Education Dept.

LABORATORY ASSISTANT required at Tottenham Technical College, High Rd., London, N.15, for Dept. of Science from Sept. 1962. Should have knowledge of practical work for Ordinary & Advanced Level courses in Physics, Chemistry or Biology. Some evening duty. Facilities for further study available. Salary Misc. III £555-£625 plus London Weighting up to £40.
Prescribed conditions. Application forms (s.a.e.) from Principal, above address, returnable by 2nd August. (Quote K.977N8).

PERSONAL

INVENTORUS LIMITED

Our team of consulting experts is available to advise and assist you in all technical and commercial phases of the successful development of your inventions.
Write to:

The Commercial Director,
INVENTORUS LIMITED,
278/282 High Holborn, W.C.1.

INPUT (HOLborn 2357) write, draw, record, film, photograph, build Industrial Training Aids. INPUT LTD., 34 Great James Street, London, W.C.1.

APPOINTMENTS AND SITUATIONS WANTED

CHEMIST, nine years' experience in surface coatings industry, comprising research, process control and production supervision seeks position demanding enthusiasm and flexible outlook. Some experience of radio engineering is available; all types of work considered, particularly if available in North-West England. Box C785 NEW SCIENTIST.

BOOKS

THE FOURTH LAW OF MOTION' A startling article by U.S. research scientist Dr. William Davis appears in the August issue of ANALOG magazine, 2/6d. from newsagents or plus 6d. postage from Atlas Publishing & Distributing Co., 18 Bride Lane, London, E.C.4.

LECTURES, MEETINGS AND COURSES

UNIVERSITY COLLEGE OF NORTH WALES, BANGOR

Department of Zoology
Advanced Course in Embryology and Mammalian Reproduction

Applications are invited from graduates with an honours degree in Zoology, Physiology or Anatomy, or with a Medical or Veterinary qualification. The course will last twelve months and lead by examination and dissertation to the degree of M.Sc. D.S.I.R. Advanced Course Studentships will be available for the support of eligible students attending this course.

The course is designed to cover the principles of vertebrate embryology, descriptive and experimental with particular reference to mammals, placentation, the physiology of foetal life, transmission of immunity, oestrous cycle, reproduction in the male mammal, sterility and prenatal mortality.

The course will commence in October, 1962, and will lead to an examination in June, 1963, and the presentation of a dissertation in September, 1963.

Applicants should write to Professor F. W. Rogers Brambell, F.R.S. Department of Zoology, University College of North Wales, Bangor, Caernarvonshire, from whom application forms and further particulars may be obtained.

CHEMISTRY, BIOLOGY, ZOOLOGY

Tuition by university graduates, small groups, own laboratories.

Day and evenings. A & O. levels. Also tutors for all subjects. University entrance and professional exams.

CARLISLE & GREGSON LTD.
5 Lexham Gardens, W.8. FRE 1287

BECOME a Qualified Engineer, Draughtsman, Surveyor or Builder. Over 200 Guaranteed Diploma and Exam Postal Courses. Many First Places. Valuable 32-page Guide—FREE! Write: NTE (Dept. 356), 148 Holborn, London, E.C.1.